This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

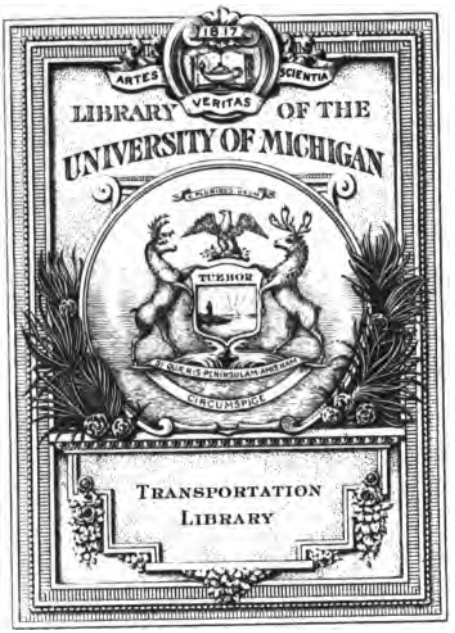
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

A 753,280 DUPL


1817
ARTES
SCIENTIA
VERITAS
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
TUEBOR
SI QUAERIS PENINSULAM AMOENAM
CIRCUMSPICE
TRANSPORTATION
LIBRARY

Transportation
Library
VM
605
.B79

Wm. Hatcher
from the Auth

STEAM NAVIGATION,

ITS RISE AND PROGRESS,

WITH AUTHENTIC TABLES OF THE EXTENT OF THE STEAM MARINE OF ALL PARTS OF THE GLOBE, CONTRASTED WITH THE STEAM POWER OF THE BRITISH EMPIRE;

IMPERFECTIONS OF THE PRESENT SYSTEM OF STEAM NAVIGATION,

AND

SYMINGTON'S INVENTIONS.

WITH DRAWINGS OF THE ORIGINAL STEAM BOATS, AND LATEST IMPROVEMENTS.

BY BOYMAN BOYMAN, ESQ.

"Mankind, just now, seem wrapt in meditation,
On Constitutions, and Steam Boats of vapour.
. . . . . .
With all kinds of mechanics, and full soon,
Steam Engines will conduct him to the Moon."
D. J., xii. *and* x.

LONDON:

A. H. BAILY & CO., 83, CORNHILL.

1840.

LONDON:

PRINTED BY BALNE BROTHERS, GRACECHURCH STREET.

Museum Book Store
11-6-'31
Transf.

APOLOGETICAL PREFACE.

THE reader will observe, with surprise perhaps, that the first pages of this pamphlet are taken up with a detailed account of the imperfections of the present system of Steam Navigation, and with the description of an invention to obviate them. The design with which it was written precluded the first part appearing in its proper position at the end, after the account of the rise and progress of this great power had naturally led the reader to take more interest in an inquiry into its chief drawbacks, and the means of their prevention. No apology is necessary for dwelling upon them at length, since these evils were considered of sufficient magnitude to deserve the attention of eminent engineers in England, France, and America; of their respective governments, of their first chemists, and philosophical inquirers. The causes that produce them have been well investigated, and are well ascertained; but they have not led to the discovery of a remedy by any of that body. Excepting, indeed, the safety-lamp of Sir Humphrey Davy, the useful arts are but little indebted, for practical results, to the class called philosophers. The Cartwrights, Comptons, Arkwrights, Watts, Symingtons, and Whitneys, who, within the short space of thirty years,

have thus only to offer my desire to do justice to a talented individual, whose neglect was in proportion to his merit, and a collection of facts, that may not be useless for reference, for this badly-arranged and immature production; the first effort of a writer without experience in the graces of composition, unpremeditated, and wholly unexpected. Much will appear repetition; but allowance will be made for the circumstance that I have taken up the subject only as opportunity allowed me, and never continued it three hours together. Neither must it be forgotten, the difference between stating a fact and establishing one; a sentence may serve for the first, a volume sometimes is required for the other, if the writer seeks (what, to avoid the *cacoëthes scribendi* replies, every writer ought to seek, or else not attempt at all,) to set a disputed question at rest for ever. Had I paid as much attention to the arrangement and composition as I have done to accuracy in the data and Tables, I should ask no indulgence. Obliged to notice the Steam Engine, in tracing its application to Navigation, I took the opportunity of treating its history in a manner entirely new, especially in distinguishing more prominently, at pages 75 and 76, what has always been the criterion of its excellence—the method of condensation. I sought also to give to this wonderful machine those attractions for the general reader which I had not seen elsewhere, embracing, at the same time, all the information necessary for this class of readers, but not that knowledge, which none but the engineer requires. Doubtless, without drawings, it may be difficult to convey a clear impression of the different improvements on the Steam Engine; but, believing that what is seen distinctly can be described accurately, I have depended upon this simple resource, and familiar words, to convey the meaning. I would observe that I have little confidence in

awarding, at page 70, the merit of the first Steam Engine erected in England, to the Marquess of Worcester. My authority for this novel statement will be found at page 325 of the Travels of Cosmo the Third, in Great Britain, in the reign of Charles the Second, in 1669, not 1653, as stated. Though I have been puzzled what other machine to understand by it, the description is not sufficiently clear to my mind, to leave no doubt of its being the steam engine.

The paddle-wheel here described may be considered an improvement upon the common wheel for Sea Navigation, yet I certainly give the preference, for such purpose, to Smith's Screw Propeller, which, since these pages were struck off, has attracted considerable attention as applied to the "Archimedes." It is needless to dwell upon superiority so evident, as the certainty of an easy moving power being, under all circumstances, immersed to its proper depth, over the variable dip of paddle-wheels, one of which is frequently immersed up to the axle, whilst the other is revolving in the air. The propeller, besides, possesses many collateral advantages superior to any paddle-wheels, and will no doubt completely supersede them. Whether it possesses equal power in smooth water is questionable, but at sea any loss is more than supplied. Altogether it is a very great improvement in Steam Navigation.

The horizontal Windmill, here noticed, is better calculated than any other yet invented, to set at rest the long disputed question in mechanical science, whether any horizontal Windmill can have more power than the vertical mill? Hitherto the experiments cannot be considered conclusive, on account of the great friction of the feathering motion of horizontal mills; but in the one now noticed this is reduced to the smallest possible amount, to far less, indeed, than in the best vertical mill, and being quite a new motion so applied in mechanics, it becomes an interesting problem to determine.

Mr. Symington's inventions being recorded in these pages, it may be proper to observe that he is not responsible for any errors, as I was not able to avail myself of any suggestions in the MS. or the proofs. Errors, though I believe not errors of principles, may therefore be discovered, but the discriminative reader will not consider them sufficient to entitle what is sound in itself to no confidence. I have said thus much, aware that when we have been accustomed to let great names think for us, unless the authority of a great name meet us in the title-page, we are frequently but too little inclined to consider worthy of dependence the work of an unknown writer. We do not trouble ourselves to invalidate by argument what he writes, but adopt the much shorter course of destroying its value by prejudice. Much of what is here written may be found opposed to the opinions, the prejudices, and interests of others. Do I then expect too much in requesting that it may not be merely asked who writes it, as if that alone were sufficient to carry refutation or conviction of a novel assertion, but that the substance may be proved erroneous, if it be so? When we seek principles for the foundation, and apply common sense for the scaffolding, we may hope to attain, by just degrees, to the eminence of truth; and, as I hope always to remain open to conviction, I shall thankfully receive whatever may convince me of error.

It is difficult in a first attempt to acquire that rigorous self-control to prevent straying from the text. I have thus exposed myself to the "swashing blow" of the ingenious critic, who will find in this, as probably in most early works, "ample room and verge enough" for the exercise of much pleasant banter.

B. B.

City Club,
17th March, 1840.

CONTENTS.

Introduction—Difficulties Steam Navigation has to contend against, from which Railway Travelling is free—Quantity of Coals necessary, taking up great part of the steamer—Rapid Destruction of the Boilers—Difficulty of repair at a distance from England—Public attention directed to Communication with India by Steam—Report of two Committees thereon, in 1834 and 1838—Applied to the "City of Londonderry," and abandoned—No cause assigned—Recorded as an example of its failure—No Invention perfect on a first trial—Advice to Inventors . . . vii

CHAPTER I.

Symington's Condensation by Injection—Objections to the present system of Steam Navigation—Incrustation of the Boilers; useless expenditure of fuel in consequence, and their rapid destruction—Origin of the Invention—Absurdity of limiting the means offered by nature, by condensing inside, by unwieldy tanks, when the open sea or river might be used—No alteration of the engine necessary, nor of the principle of injection—Vessel, therefore, never delayed by accident to the pipes—Not more liable to injury than the keel or hull—As securely attached as one of the planks—Danger from Explosion, from carelessness of Engineers, removed by Symington's plan of supplying the boilers with pure water 11

CHAPTER II.

Objections to Symington's plan shown to be groundless, by the simplest comparisons—None made, that two years' experience have not disproved—Objections to all new inventions—Mr. Watt's Separate Condenser, his greatest discovery—Not introduced before ten years—Mr. Ritchie's opinion 17

CHAPTER III.

Practical working of the plan—Six voyages across the Bay of Biscay, enabling the "City of Londonderry" Post-office steamer to make her passage in time—Since applied to the "Dragon," of 60-horse power, working for two years; saving nearly one-third the fuel; boilers as clean as when made; not blown out nor chipped during that time—Important difference in expense of boilers, between the "Dragon" and another boat belonging to the same Company, not supplied with the plan—Such evidence conclusive—Lately applied to another vessel with success—Pipes effectually protected to meet objections—Attempt to injure the plan, by stopping up injection pipe—Inventions frequently condemned by careless inquirers, from causes independent of their merits . . . 22

CHAPTER IV.

Attempts to prevent incrustation by condensing without the jet—Other disadvantages in consequence—Numerous joints liable to get out of order—Space occupied—A good vacuum no criterion alone of its efficiency—Loss of power from condensing by surface—Larger Air-pump required, and extra Force-pumps to supply the tanks—The properties of steam prevent the same duty being obtained from a non-injecting engine, as from an injection engine of the same power with Symington's plan—Accidental Discovery of Condensation by Injection—Mr. Watt's Experiments—Letter to Mr. Smeaton, giving the preference to an injection—Great authority 28

CHAPTER V.

Extracts from Reports—Steam vessel accidents—Evidence on destruction of boilers, and causes of explosion—Loss of the "Forfarshire;" Official Letter to Lord John Russell on the cause—American Report on causes of ninety-nine Explosions . . 34

CHAPTER VI.

Mr. Farraday's Experiments, and Evidence on Causes of destruction of marine boilers—Waste in fuel by present system explained—Analysis of salt water—Depositions by evaporation—Saving by using fresh water 40

CHAPTER VII.

Concluding observations—Certificates useless if at variance with principles—Prejudice must be removed by anticipating objections—Summary of the advantages offered by this plan—Importance of it for steamers distant from England—Saving of nearly one-third of fuel, even in river water—Criterion of perfect inventions, simplicity in the means, efficiency in the end—Mr. Watt's separate Condenser analogous—Symington's Invention does for Steam Navigation, what that did for the Steam Engine 48

Symington's Fixed Paddle Wheel for Ocean Steamers 57

Beautiful motion for a horizontal Windmill 63

RISE AND PROGRESS OF STEAM NAVIGATION.

CHAPTER I.

History of the Steam Engine necessarily involved in it—Three periods only requisite to be specified, to convey a general knowledge of most inventions; origin, first imperfect application, and greatest improvement—Hero of Alexandria, 120 years B. C.—Marquess of Worcester and Newcomen, 1653 to 1705—Watt's separate Condenser, 1765—the three principal epochs of the Steam Engine—All the improvements of nineteen centuries insufficient to render it a useful machine, until Watt's inventions—Watt the genius of the Steam Engine—Its powers, and what it has done for England—Sir Walter Scott and Lord Jeffrey's eulogiums 69

Lord Brougham's Epitaph on the monument sculptured by Chantrey, to the memory of Watt—Rare combination of talent . . . 87

CHAPTER II.

Application of Steam to Navigation—Difficulty in ascertaining the real Author of an Invention—Causes—Hard fate of Inventors—Chambers' Edinburgh Journal and the late Mr. Symington—Mr. Symington the real Inventor, by first proving its practicability 88

CHAPTER III.

Rise and progress of Steam Navigation.—Blasco De Garay, in 1543 —Marquess of Worcester's idea enigmatical—Papin suggests it in 1690—The First practical Steam Boat described by Jonathan Hulls, in 1737—His opinion, a century ago, of what "the scheme" would become "if encouraged"—Never tried—The late Mr. John Rennie's opinion of claimants—Marquess De Jouffroy, 1781—Suggested and tried in France, next to Blasco De Garay, in Spain—Mr. Symington the real Inventor of Steam Navigation, as Mr. Watt of the Steam Engine—Object of the question, Who invented them?—Mr. Symington's, the first boat propelled by steam on British waters, in 1788—Lord Stanhope's, in 1795, the next—Mr. Symington's success, in 1801, 2, and 3 complete with the "Charlotte Dundas," the first Steam Boat named in England—Bell's "Comet," 1811 . . . 91

CHAPTER IV.

Rival claims to the invention of Steam Navigation set at rest by dates—Miller, Taylor, Fulton, Bell—Symington's Letter to Taylor explained—His claim upon national gratitude considered —The principle which should govern such rewards . . 99

Authorities in favour of Symington's claim to the invention of Steam Navigation 113

Table, No. 1, of the Rise and Progress of Steam Navigation in the British Empire, chronologically arranged 125

Commentary on the preceding Table, with reference to America—The ridicule with which Steam Navigation was received in the United States—Derided "as an idle and whimsical project"—Report of the American Philosophical Society—Fulton's efforts—His interesting description of his first Steam Boat—Names of vessels which first established river and sea navigation by steam, and dates—Iron Steam Boats 126

Analysis of data—Summary of the Progress of Steam Navigation, and the merit due to the several projectors—America still continues to claim the honour for Fulton—Investigation of the grounds, and his claim to be considered as "the benefactor of the human race"—His merits as an engineer 135

Table, No. 2, of the Number and Tonnage of the registered Steam Vessels only, in the British Empire, in 1838 142

Table, No. 3, of the Number, Tonnage, and Horse-power, registered and unregistered, of the Steam Vessels in the British Empire, in 1838 143

Dimensions of the five largest ocean Steam Ships 144

Steam Marine of the United States, in 1838 147

Steam Marine of all parts of the Globe, in 1836 150

Rise and Progress of the Steam Navy of Great Britain 151

Strength of the combined powers of all nations in sea-going Steam Ships only, compared with the British Empire 151

Remarks on the preceding Tables—The probable use of Steam Vessels in a future war—Great superiority of the British Empire in sea-going vessels—A majority of 250, after leaving sufficient to cope with the combined Steam Marine of every other power . . 152

Passing remarks upon the probability of Great Britain continuing the first Naval power—Causes that have led to her superiority—Geographical position—Colonies—Carrying trade—Dense population and inadequate territory—Still existing in greater force . 155

The population of France, Russia, and America, not endowed with the same physical and mental qualities to lead them to the sea—France has produced few good Navigators—Her population dislike the sea—Propensities lead to distinct occupations, though opposed by Sir Joshua Reynolds and Dr. Johnson 156

The Navy of Great Britain the offspring chiefly of pride and necessity; illustrated by examples of the writer's family—Contrast in the fortunes of those who followed the Mercantile service and the Navy during the last war—More encouragement required for the Navy—Should be made the most popular branch of the United Service in this country, as the army became in France . 159

Concluding Observations—The future prospects of the British Empire connected with Steam Navigation—The vast trade it will open on the rivers in India, Africa, and New Holland—The means of relieving the distressing famines in India by such facilities of intercourse—England considered in her infancy, and an exception to Lord Bacon's apothegm—Why 164

Description of the Drawings of the late William Symington's Inventions 173

INTRODUCTION.

If we would gain knowledge, we must inquire; if we would inquire with advantage, we must investigate without prejudice, and judge without interest; but neither investigation nor judgment is of any avail, unless our decision influence our actions.—*Common Sense.*

THE wants of a great commercial and enterprising nation, are constantly exciting the ingenuity of its people to improve the facilities of intercourse. The cause of the prosperity of all countries, and the chief means of increasing it, the thoughtful mind is struck with wonder and admiration at what has been accomplished in our own, within only the last twenty years. A great and unexpected step has been taken, both at sea and on land, from a tedious and uncertain conveyance, to the luxurious ease of rapid motion, as safe as certain. Yet the progression stops not, but gathers fresh vigour from every exhibition of the power of steam, surprising and prodigal as it is. A friendly rivalry of extension now exists, with unexampled energy, between the two great antagonists, land and water communication. The former is without limit, because without drawbacks. The greatest obstacles to the equally rapid extension of the latter, are found in the enormous consumption of fuel, the more valuable space it occupies, the rapid destruction of the boilers, and their difficulty of repair at a distance from England. No plan, combining simplicity, cheapness, durability, and efficiency, has hitherto been discovered to remove them. An

invention that now professes to do so, possessing these requisites, and without substituting a single disadvantage, has, at least, a fair claim to the unprejudiced inquiry of all who are interested in the subject. So many useless "improvements" are brought out, with a formidable array of certificates, (no plan too absurd to find its advocate or dupe,) that Steam Shipping Companies are worried to death by the importunities of the too sanguine inventor, and are compelled to pay no attention to any of them. The good and bad are classed together, from the great majority of the latter; and Steam Boat Proprietors are content rather to go on with the good old plan, than by trying those which have not stood a year or two's experience, "float like Pyrrho on a sea of speculation."

The present period of Steam Navigation is, perhaps, the most interesting of its history. We see this mighty power struggling, with a giant's strength, to release itself from the remaining fetters which prevent its universal dominion instead of wind, seeking to compass the globe, and unite all nations by one great chain of steam-boats. A sweeping revolution in the navigation of the world is fast rolling onward, taking its rise in the skill, capital, and enterprise of British merchants, so that the time may come when a sailing-vessel of any size will be known only for its singularity, and the waters of no navigable sea or river in any of the nations of the earth remain untraversed by its means. Public attention has been already twice directed, by the valuable Reports of Committees, in 1834 and 1838, and is still alive, to the practicability of uniting, by steam power, our vast distant colonial possessions in nearer relations with Great Britain—an object of great and increasing importance.

Never, since the application of Steam to Navigation, has an invention of greater pretensions been offered to public notice; professing to do so much, and which, if performed, will leave so little for others to do. Under any circumstances, by either of the routes proposed, a regular and certain communication with India will scarcely be found to answer with the present system of steam navigation. The remedy now discovered professes to do as much as can be done to render practicable what is now doubtful.

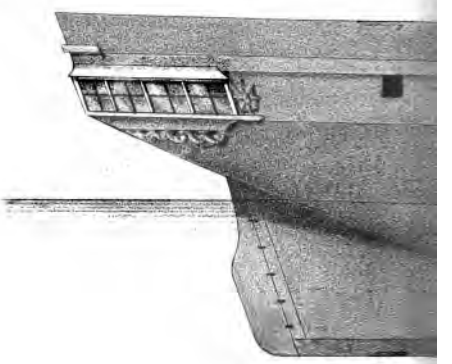
It will be seen, by the evidence in the following observations, that a two years' constant working of this plan has proved, beyond all question, a saving of nearly one-third of fuel, by means so simple as to render it not more liable to derangement than the engine itself. A steamer to India, of 500 horses power, must carry 800 tons of coals, upon the old plan; but by using Symington's condensation, she need take only 600 tons, reckoning the saving, at the lowest amount, one-fourth, which it always exceeds. This allows her 150 tons more goods, taking into account the difference between the dead weight of coals and measurement. The gain by additional freight alone would be very great every voyage, independent of the considerable saving in fuel and boilers.

It is stated in the following pages, that the condensation was applied (the first time it was tried) to the "City of Londonderry," and abandoned.* This fact having been recorded lately, as a precedent of its failure, application was

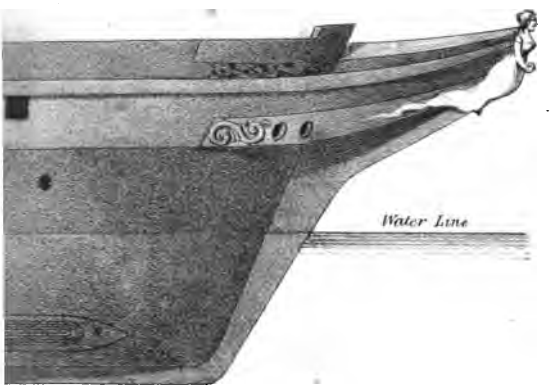
* It is desirable, in all cases, to distinguish the sources of evidence. I would observe, in reference to what is stated of the "City of Londonderry," what Gibbon said of his Mémoire Justificatif, "I spoke as a lawyer from my brief." The certificates and letters, from which the facts are taken, are in my possession.

made for the cause of its discontinuance. The information was refused; and, as no positive reason was assigned at the time the pipes were removed, conjecture only remains. That they were not removed for causes affecting the merits of the invention, its constant use for two years affords sufficient evidence. The inventor who is struggling through innumerable difficulties, to introduce what his genius instructs him is a valuable discovery, may be saved many disappointments by this example. However strong may be his conviction that his invention will perform its object, he must not apply it at his own expense, upon the chance of payment "if it answer to satisfaction." He will but pay for his own undoing. "Satisfaction," in agreements, is an unmeaning word; 'tis too wide a measure of contingent precaution, to place the inventor upon equal, or even on fair terms. He may refer to certificates and facts that it has performed all that was promised on the one part, and all that was expected on the other. No matter, "satisfaction" need not be governed by facts; it can never be ascertained, for what has no limits can never be defined. Proprietors of steam vessels cannot attend to the engineering department, however anxious to act justly; they are compelled to trust to reports, and are constantly deceived. Those who have little acquaintance with the history of great inventions, may fairly ask, would this plan have been discontinued had it performed what it professes? They will find, however, that it has ever been the case, that individuals will not, until compelled by their own interests, part with present money to secure future advantages. When a more far-seeing and clear-minded individual has adopted some new discovery, which mankind will be ever drawing from obscurity, others of the same occupations are then obliged to adopt it, to

enable them to compete with their neighbours. This was the case to a striking degree in Cornwall, on the introduction of Watt's inventions. It was the case with Steam Navigation, Railroads, Gas, and other valuable discoveries, and probably will always continue so; and those who estimate the value of an invention by a first trial, will not display quite so sound a judgment as Mr. Watt, who persevered in his great works because they were *not* perfect on their first application. If we run over the list of those surprising discoveries in Surgery, Medicine, and the useful arts, which give more value to existence, and learn the mass of bigotry in past times, and of prejudice in the present, with which they were first received, we shall gain some knowledge of the unceasing efforts necessary to overcome prejudice and the rivalry of contending interests, and find the truth of the observation of the admirable Burke, "We must keep up the top with continual agitation and lashing; the moment it ceases to spin, it is a dead bit of box."



UNIV. OF MICH.



Waterlow & Morland Lithog.rs 24. Birchin Lane. London.

IMPROVEMENTS

IN

STEAM NAVIGATION.

CHAPTER I.

SYMINGTON'S IMPROVED METHOD OF CONDENSING BY INJECTION, TO PREVENT INCRUSTATION; BY WHICH GREATER DURABILITY OF THE BOILERS, FREEDOM FROM EXPLOSION FOR WANT OF WATER, AND A SAVING IN FUEL OF NEARLY ONE-THIRD, ARE ENSURED.

THE incrustation of boilers of marine engines has been long acknowledged one of the greatest drawbacks to Steam Navigation, and the many evils arising from it, whether in impure river water, or at sea, are too well known to require minute description. In river steamers, where the water holds in solution, mud, chalk, lime, or other impurities, the wear of the boilers, owing to the depositions, is scarcely less rapid than in sea-going vessels. But in these in particular, the loss of power from blowing out, frequently every four or five hours; the dangerous injury done to the boilers, if omitted through carelessness or design; the useless expenditure in fuel, to heat the great quantity of water thus wasted; the valuable space occupied by nearly one-third more coals than would otherwise be required; the loss of just so much freight; together with the detention of the vessel, taking up her decks, docking, and incidental heavy charges for repairing the boilers, owing solely to this cause; the constant annoyance of blowing, and chipping, and cleaning them; and the

rapid destruction of the boilers themselves, even under the most careful engineers, render the present system of Steam Navigation open to great improvements, besides forming considerable deductions from the profits of every Steam Shipping Company. The removal of all these annoyances; the absence of all doubt whether the boilers will last another, or another, or another voyage, each time the vessel returns; the serious loss or injury that may arise to a Company, if the judgment should be found erroneous in this respect; economy of space and fuel; the durability of the boilers, and the certainty of no danger from undiscovered incrustation or want of water, are objects of the first importance; and whatever will, in a simple, durable, and effectual manner, produce these results (without originating other disadvantages) must, certainly, be considered an important advance towards perfecting this vast agent of extending British commerce and communication.

The inventor, the son of the late William Symington, the originator of Steam Navigation, is encouraged to believe that he has devised a remedy for these evils, simple and cheap in its application, taking up no room, adding nothing to the tonnage of the vessel, and perfectly efficient in its operation. It appeared to him not a little singular, that so many attempts should be made to condense *inside* the vessel, by means of ponderous tanks, occupying valuable space, and which, at the best, must be but imperfect coolers, when there was so simple and perfect a condenser outside, as the open sea or river.

Following up this happy, though bold idea, he could entertain no doubt that, by cooling down the water in the hot well to the temperature of the external water, by means of pipes so placed *outside* the vessel as to receive the direct action of the water, in order that condensation might be effected by injecting, again and again, a portion of the same water, while the remainder was returned to the boiler, he

would succeed, more especially as such a plan would involve no alteration in principle, in producing a very simple and perfect mode of preventing incrustation, applicable, with admirable facility, to any vessel, in a few days, and without making any alteration in the engine itself. By his method, the injection water, after condensing the steam, is conveyed in the usual manner by the air-pump into the hot well, from whence a portion of it, instead of being wasted, enters the refrigerating pipes outside, so placed as, in any rolling or pitching of the vessel, to be considerably beneath the line of flotation; and, by the rapidity with which they are brought into contact with the constantly changing particles of water, by the motion of the ship, every portion of warmth is speedily given out; and, before the water completes its passage to the condenser, it becomes of the same temperature as the external water, and ready for injection again. The remaining portion of the water escapes to the boiler by means of a float *in the hot well*, which moves on friction rollers, in front of the orifice leading to the feed-pump, and rises and falls freely with the rise and fall of the water in the hot well.

By this simple means, the supply and circulation of the blood in the body can scarcely be more regularly adapted to the calls upon it, than the supply of water to the boiler is in exact proportion to its wants and the speed of the engine. Only the precise quantity of injection water and condensed steam, that is necessary to supply the deficiency in the condensing pipes, for the purpose of injecting again, will find its way in that direction, (for they can but be full,) whilst the residue, which is also the precise quantity of water evaporated and condensed at each stroke of the engine, will find its way into the boiler by means of the feed-pump; and thus, by keeping the water always at the same height, remove the serious danger arising from the carelessness of engineers neglecting a proper supply. The steam from the safety-

valve can, if desired, be condensed by leading it into the external pipes; and, by applying a small cock to the pipe, near its entrance to the condenser, the engineer can, at all times, ascertain the temperature of the injection water, and, by its circulation and purity, that the pipes are free from injury. These will be made of the best stout copper, so as to be abundantly durable, and will, in fact, require repair less frequently than the copper sheathing of the vessel.

It requires but little consideration to determine, beyond all doubt, that this mode of preventing incrustation cannot fail, because it is precisely the same in principle as the common injection-jet, only distilled instead of sea water being used for that purpose. The engine itself, too, does not require alteration—another advantage peculiar to this plan; for all that is required, besides the addition of the pipes to the outside of the vessel, are two cocks, one to turn off the old injection passage, the other to prevent the escape of the water from the hot well. These are left free to act, that the engineer may, at any time, put to the test, without collusion, the comparative advantages of the old and new plans; ascertain to a pound, beyond all dispute, by using either alternately, and under every variety of trial, what is the real saving in fuel; or, to have recourse to the old plan, upon emergency.

But it is not the least advantage of this simple method, that the vessel can never be delayed by injury to the pipes; for, although it will be seen by the drawings, that they are quite out of reach of accident but of that serious nature that would be equally destructive to the vessel itself, yet, should they be injured by any means, independent of the remedy of the old plan, singularly enough, the very cause of the injury will of itself prove the remedy; for the water will naturally follow the cause, and flow through the pipes into the condenser, just as if the opening were the usual

injection passage: so that the cessation of Symington's plan, and the substitution and commencement of the usual one, must be simultaneous. Thus it is, that the simplicity of the means employed; its perfect efficiency; its durability, and consequent cheapness, compared with other plans, as well in its first cost as afterwards; the little liability to derangement, and, should an accident happen, the momentary readiness with which the old plan can be resorted to, *together with the principle remaining unaltered in the application, rendering failure impossible,* entitle such a mode of preventing incrustation to the careful investigation of all who are interested in Steam Navigation. The pipes can be placed in any position that may be thought most secure to suit particular fancies; with equal advantage, either as represented in the drawing, or completely under the vessel's bottom—the upward pressure of the water thus tending to keep them in their place. Where the vessel, however, takes the ground at her moorings, there is abundance of space between the keel and the light water line to attach them, equally secure from injury, as was done to the " City of Londonderry."

It appears by the evidence embodied in the late voluminous " Report on Steam Vessel Accidents," that the lamentable loss of life, occasioned by the explosion of boilers, is frequently to be attributed to the carelessness of engineers allowing the water to get too low. The excessive heat acting upon a small quantity of water decomposes it, generating, instantaneously, a most destructive gas, which, the writer conceives, no safety-valve would be sufficiently capacious to discharge in time to prevent the explosion that must then inevitably ensue. This, indeed, may be considered a matter of minor importance; but the writer would infinitely prefer, on a long voyage, going to rest with a feeling that such a fearful calamity could not occur. In this plan, the chief danger from a cause which, so long as it depends upon the attention of the

engineer, must at all times be in operation, is wholly removed, by being placed beyond his control; for the engine, more constant in the discharge of its duty than the engineer, takes upon itself his office, and returns to the boiler, at each stroke of the engine, just as much water as had been previously evaporated; so that the boiler always contains the proper quantity whilst the vessel is in motion. And the little steam that passes from the safety-valve, when the engine is at rest, either into the refrigerating pipes, or into the air, as choice may give the preference, cannot reduce the water so low as to occasion danger.

CHAPTER II.

OBJECTIONS TO SYMINGTON'S PLAN SHOWN TO BE GROUNDLESS, BY THE SIMPLEST COMPARISONS.—NONE MADE, THAT TWO YEARS' EXPERIENCE HAVE NOT DISPROVED.—OBJECTIONS TO ALL NEW INVENTIONS.—MR. WATT'S SEPARATE CONDENSER HIS GREATEST DISCOVERY.—NOT INTRODUCED BEFORE TEN YEARS.—MR. RITCHIE'S OPINION.

THAT an invention which will ensure the duration of the boilers, is not likely to be well received by some boiler makers is very probable. The author of a discovery has to contend against the interested, prejudiced, and jealous; and the history of every invention of value has furnished distressing evidences of the fact. Even Mr. Watt's great discovery was ten years before it was used, though it saved at once nearly three-fourths of the fuel, and rendered perfect what before was comparatively useless; but the respectable engineers who gave their evidence before the Parliamentary Committee, on Steam Navigation to India, have shown how desirable an improvement of this kind would prove, and how readily they would receive it. It is hoped, therefore, that no plausible theories, arising, for the most part, from prejudice or interest, and proved erroneous by a long trial, will deter others from forming their own opinion of an invention which has such claims for investigation by the obstacles it removes, and the authenticity of the facts.

Diverted from inquiry by what is new opposing some preconceived opinion, or starting at once some grand objection they think insurmountable, people are carried away by general impressions, and arrive at erroneous conclusions,

only because they will not examine the details. The idea of exposing pipes to the action of the sea has appeared to some so perilous, that they have ceased to read further than the description of the drawing, not stopping to consider, that if a moveable machine like the paddle-wheel, sometimes in and sometimes out of the water, exposed to the violence of every sweeping wave, can be made to stand rapid and powerful concussions in opposing the sea, driving along in the heaviest gale, with the power of 4 or 500 horses, that which is immoveable, of little compass, closely packed, and, owing to deep immersion, never exposed in that manner, can be as securely attached to the vessel as the keel itself, and with no more risk of separation or injury.

So much may be unfairly said on this point, that it is proper sometimes to notice an objection, simply to prove its fallacy, though in itself it may deserve no attention. The prevalence of an opinion, however, is no evidence of its correctness; but rather, as there are many paths to error, but only one to truth, the probability is, that the careless observer—and of such is the world chiefly composed—will mistake the right. We ought not, therefore, to pin our faith to so treacherous a guide as general opinion; but, looking carefully to the weight and character of the evidence, form our own, and encourage the honesty and firmness to maintain it.

It may then be fairly asked, What protection do these pipes require, that the keel or part of the vessel they cover does not require? It is not reasonable to say they can be more liable to injury; and yet, we do not hear of the vessel's bottom or sides requiring protection from imaginary danger. The very boldness of this plan—FOR THEREIN CONSISTS THE SAFETY OF THE PIPES, BY THEIR BEING PUT ON PRECISELY THE SAME FOOTING, IN REGARD TO SECURITY, AS THE HULL OF THE VESSEL, BELOW LIGHT-WATER MARK, AND AS FREE FROM CAUSES OF INJURY—instead of being

considered, as it must be on reflection, a distinguishing feature in its favour, is turned against it, on account of the apparent risk. The pipes may, perhaps, at first sight, appear unprotected: they strike the eye in the drawing, as being exposed; yet, all consideration removes the impression, when the question suggests itself, From what danger do they require protection? They do, in fact, receive the same protection as all other parts of the vessel under water; and it would be just as unreasonable to omit the keel, or, indeed, to give up building vessels altogether, because the keel and sides are unprotected, as it would be to object to these pipes, which are similarly situated, on the same ground. Where is the difference? What is the apprehended danger, or where is it to come from? What is certain may be met and provided against; it is only uncertainties that perplex us. What *can* there be, to start up to injure only these pipes, and not the parts above and below them? When at anchor, they are far too deep beneath even light-water line to be injured by collision, and quite out of reach of malice; and, when at sea, is the sword-fish to run a tilt at them, or is the navigation so new or intricate, that rocks are to have a point only for these pipes, knock a hole through them—of little consequence if they did—but spare the vessel? Or is it that the able captains of our fine steamers are to show their nautical skill and capability for their duty, by steering directly across the buoys or other landmarks? That these poor pipes are capable of being as securely fixed as the keel, or one of the planks, requires no thought, independent of the proof furnished by the "City of Londonderry" and the "Dragon," which will be noticed more fully by and by.

Unable to hold what is no longer tenable, these objectors are obliged to yield the point; but they next exclaim against the impediment to the vessel's speed. This objection is not less urged, and not less fallacious. The pipes are parallel,

not at right angles, to the vessel's way, and many swift yachts are carvel built, offering more irregularities. If they would deduct the part covered by the pipes, which would otherwise be exposed to the action of the water, from the surface presented by the pipes, they would find the difference to be far less additional surface than they would otherwise imagine. And what would such difference in resistance amount to, in a few copper pipes of two or three inches in diameter, on a vessel of 5 or 600 tons? Next to nothing. Attached to the large dimensions of the "Great Western," for instance, they would seem insignificant—mere streaks. The additional revolutions of the wheel, always obtained by this plan, and which, in a long voyage, must tell considerably, would more than compensate for any increased resistance, if there were any; but, if so, are there no compensating advantages? Is it nothing, the prevention of the rapid destruction of the boilers, and all the many annoyances and expense, saving nearly one-third of the fuel, and the valuable tonnage it occupies? All great advantages are purchased at a certain sacrifice; and we might with no better reason object to Mr. Watt's separate condenser, because it entailed upon the engine the additional duty of the air-pump, from which it was previously free. But an upright, honest inquiry is not always to be secured. Led away by an opinion, hastily adopted, many think they are bound by a false notion of consistency to support it, and they refuse to inquire, because they are unwilling to be convinced. No reasonable man can expect to be right at all times, and we may generally form a pretty good estimate of the soundness of his judgment by his openness to conviction; the docility of the infant is seldom united but to considerable vigour of intellect. Newton was but a child picking up pebbles on the shore of the great ocean of truth.

Before the plan was tried, the opinion of a scientific ship-

builder, well acquainted with the resistance of solids in fluids, was taken, and the following was his opinion. It is given, in justice to Mr. Ritchie, simply because the results have fully confirmed it on both points.

" Clyde Dock, Rotherhithe, 10th May, 1837.

" Mr. Symington.

" Sir—It is my opinion that your condensing tubes or pipes could easily be fitted to any vessel's bottom, at the angle formed by the keel and garboard streak, where they could not be washed away by the action of the water, and that they could be so fitted as not in the least to impede the progress of the vessel; and I consider your plan of refrigeration as very simple, and likely to be very effectual.

" I am, Sir, your most obedient Servant,

" Joseph H. Ritchie."

With a minuteness which may appear tedious, but which the writer believes the subject and the authenticity of his materials rendered preferable to confusion, from affected brevity, he has hitherto been dealing more with the theory and principles of the invention, seeking to make them thoroughly comprehended by every one, than with corroborative evidence. He now comes to practical results, which always deserve more attention, in proportion as they are not opposed to our previous knowledge of any reason to render them improbable.

CHAPTER III.

PRACTICAL WORKING OF THE PLAN.—SIX VOYAGES ACROSS THE BAY OF BISCAY, ENABLING THE "CITY OF LONDONDERRY" POST OFFICE STEAMER TO MAKE HER PASSAGE IN TIME.—SINCE APPLIED TO THE "DRAGON," OF 60-HORSE POWER, WORKING FOR TWO YEARS; SAVING NEARLY ONE-THIRD THE FUEL; BOILERS AS CLEAN AS WHEN MADE; NOT BLOWN OUT OR CHIPPED DURING THAT TIME.—IMPORTANT DIFFERENCE IN EXPENSE OF BOILERS, BETWEEN THE "DRAGON" AND ANOTHER BOAT BELONGING TO THE SAME COMPANY, NOT SUPPLIED WITH THE PLAN.—SUCH EVIDENCE CONCLUSIVE.—LATELY APPLIED TO ANOTHER VESSEL.—PIPES EFFECTUALLY PROTECTED TO MEET OBJECTIONS.—ATTEMPT TO INJURE THE PLAN, BY STOPPING UP INJECTION PIPE.—NEARLY SUCCESSFUL.—CAUSE REMOVED.—NEW METHOD WORKED BEAUTIFULLY.—INCREASE IN REVOLUTIONS OF THE WHEELS.—INVENTIONS FREQUENTLY CONDEMNED BY CARELESS INQUIRERS, FROM CAUSES INDEPENDENT OF THEIR MERITS.

THE constant working of this plan, for nearly two years, under every circumstance of trial, on a tug-boat of 60-horse power, without injury to the pipes—exposed in winter to an accumulation of ice—bearing, unmoved, repeated passages across the Bay of Biscay, on a vessel of 180-horse power, with a constant saving of nearly one-third of the fuel; together with the various certificates of its advantages, in possession of the Patentees, are the evidences upon which they claim the confidence of the public in the efficiency of the invention.

The first vessel to which this mode of condensing was applied, was the "City of Londonderry" Post-office Steamer, of 180 horse power. Previous to that trial, not even an experiment had been made on a small scale, and there are

few inventions which can boast of more success on a first attempt. It is true that, owing to this cause, an error was made in a deficiency of pipe, and about one-third of the old plan of injection was used in conjunction with the new, to aid in condensing the steam. Nothwithstanding this, only 13 cwt. of coals per hour were consumed; but when the Symington plan was turned off, and the common plan worked by itself, from 18 cwt. to one ton of coals per hour were consumed, being a saving of nearly one-third, though under the disadvantage of using a portion of sea water.*

With this plan in operation, the "City of Londonderry" crossed the Bay of Biscay five or six times, in the worst period of the year—September to March—with boilers well supplied with steam, and free from incrustation; and it was remarked by those on board, how much steadier the vessel steamed, and how much better her engines worked; the pipes acting, probably as bilge pieces, rendering the vessel less crank, and enabling the wheels to do better duty, from diminished rolling, consequently adding somewhat to her speed. It is unnecessary, perhaps, to observe, that the less rolling the greater speed, because the paddles can only act with their full power in a line parallel to the motion of the vessel, at an equal immersion.

The pipes were, however, taken off, not because they did not answer, but under these circumstances:—

They were attached at the expense of the Patentees, whose agent entered into an agreement on their behalf, to remove the apparatus if it "should not be found to answer its intended purpose, to the *satisfaction* of the Company." As before stated, owing to a first trial there was a deficiency of

* This is more than the usual calculation of the consumption of fuel in other engines—7 lbs. per horse power per hour; but the proportion and saving are given as furnished by the engineer.

cooling surface, which the Patentees were not allowed to remedy. They, therefore, removed the pipes, although the Proprietors were willing to continue their use until the new machinery preparing for the vessel was fitted. That the plan did answer, is in evidence by the two years' working of it applied to the "Dragon" on the same terms, and approved of by the Directors of the Company to which she belongs. But what were the consequences of the removal of the pipes from the "City of Londonderry?" Certainly not a little singular, nor could there be better evidence afforded of the importance of the invention. A vessel that made five or six successive passages across the Bay of Biscay, in the worst period of the year, keeping her post-office time with Symington's condensation attached, was, on the two successive voyages next after the pipes were removed, unable to make the passage in time, for want of steam, though at a finer period of the year; and, shortly afterwards, she ceased to be employed in the Government service at all. The "City of Londonderry" was never tried after she was lengthened, until the pipes were attached, and thus, unfortunately for the Patentees, faults were attributed to the pipes that arose from inadequacy of power to the alteration, or other causes, afterwards ascertained by her inability to keep her time immediately this mode of condensation was discontinued. She then burnt and salted her boilers to such an extent, that her fuel was more speedily consumed, and she could not get a sufficiency of steam. There can be no better evidence of the assistance she derived from the plan, and the saving in fuel, than this fact. *When the pipes were being removed, they were found to be as sound and as fast as when first applied.* On the voyage after the pipes were removed, and the engineer was unable to get a sufficiency of steam, the vessel being in some difficulty in consequence, he observed to the captain, "This would not have occurred if we had had Symington's condensation."

The facts proving the advantages of this method of preventing incrustation, as applied to this vessel, are in evidence by the certificates of her engineers, and may be seen on application to the Patentees. One of the engineers thought so highly of it, that he has everywhere recommended it, and it has since been applied to another vessel, in which it answers beautifully.

To show, in addition to the case of the "City of Londonderry," how difficult it is to introduce a new invention, and upon how slight a cause it may be condemned, independent of its merits—Whilst the last vessel was being fitted, some unprincipled fellow, careless of the consequences, so that he injured the invention, had filled the injection-pipe with tow, and thus, when set a-going, the engine would work neither with the old nor new plan. The proprietor wrote that the pipes were to be immediately removed, stating he had been deceived in the assurance that the old plan would not be interfered with. Satisfied that what had answered during two years could not fail, a careful examination led to the discovery of this shameful attempt at injury. The new plan was immediately turned on, and, when tried against the old, always increased the revolutions of the wheels from 31 to 37. The Proprietor was quite satisfied with it!

To meet objection—and it is better to do so, however unnecessary—the pipes on this vessel were protected by a very fine, though strong, projection of about half an inch beyond them, above and below, and finely rounded at the sides. This makes them completely embayed; and they are thus represented in the drawing, to show that nothing can reach them applied in this manner. There was, however, no protection to the "City of Londonderry's" pipes, and yet they received no injury. Of so little value is experience, and so powerful is fanciful opinion.

The second boat to which the plan was applied, was

the "Dragon" tug, of 60-horse power, working at a pressure of from ten to twelve pounds on the square inch, which pressure greatly increases the difficulty of cooling. The error upon the first trial was provided against, success was complete, and the plan now equals every expectation.

It was applied to the "Dragon," as before stated, upon the same terms as to the "City of Londonderry"—that the Patentees were not to be paid for it unless approved of. The Directors of the Company to which the "Dragon" belongs did approve of it. They have had it in constant work for nearly two years, exposed to every variety of trial, that the Shareholders might not pay for an unprofitable invention. They have found a constant saving in fuel, of nearly one-third, and, since the copper pipes were substituted for zinc, which were found would not stand the ice, the boilers have not been once cleaned or chipped. When the "Dragon" was employed towing a vessel from the Helder to Dunkirk, and thence returned to London, the same saving in fuel was observed; the coals were carefully weighed, and her time noted: the boilers were not blown out once, and they were examined a few days ago, and reported to be as clean as when they came from the maker's hands. During the two years this plan of condensation has been used, the boilers have cost nothing for repairs, while another tug, whose boilers were new about the same time as the "Dragon's," have cost the same Company, in the same period, more than £200, besides her loss for detention. That tug is only thirty-five horse power, the "Dragon" two thirties; her boilers, therefore, at the same rate, and in the same time, would have cost double, had not this mode of condensation been applied. The "Dragon" has been employed in work more likely to incrust her boilers than the other tug.

Although this is a fine boat, she is the only one of her form in the river, and the most unfavourable in shape that could

be selected for the safety of the pipes; yet they have stood two years' constant hard work and knocking about of a tug, exposed to the obstructions of a densely crowded river, and barges swinging against her, uninjured; liable, from peculiar formation, to double the danger they were in on the "Londonderry." Sufficient trials have, therefore, been made to prove that no danger can attach to these pipes, that does not attach in an equal degree to the keel, and to every part of the vessel from the keel to light-water mark; and, as before stated, it is only reasonable to conclude, that unless done for the purpose, they can receive no damage. A few spare pipes on board would enable any injury to be far more speedily repaired than the serious accident to the vessel, which would alone render it necessary; and as no damage could be done to the one without the other, both might be repaired at the same time. In the Report on Steam Vessel Accidents, it is stated that in the City of Dublin Steam Shipping Company, "each vessel is placed on the gridiron at least once in every three months, merely to sight her bottom;" so that the pipes would be under sufficient inspection, though, once properly fastened, they would last just as long without looking to as the sheathing of the vessel. This Company presents one of those gratifying instances of British capital and enterprise, to be found nowhere but in this country. They possessed, in 1839, a fleet of 21 sea-going steamers, amounting to nearly 9,500 tons, of the united power of 5,550 horses, and crossed the channel 1,800 times a year. The amount of trade carried on by this one Company must be very great.

CHAPTER IV.

ACCIDENTAL DISCOVERY OR REVIVAL OF CONDENSATION BY INJECTION, IN 1711.—MR. WATT'S EXPERIMENTS.—LETTER TO MR. SMEATON, GIVING THE PREFERENCE TO AN INJECTION.—GREAT AUTHORITY.—CONDENSATION BY SURFACE AND BY INJECTION.—DISADVANTAGES OF THE FORMER.—PAPERS ON THE TWO SYSTEMS, IN MECHANICS' MAGAZINE.—SYMINGTON'S INJECTION SELF-REGULATING.

LIKE many other valuable combinations, we owe to accident the beautiful discovery of the affinity of steam for water. Newcomen's engine continued to be worked by surface-condensation until about the year 1711, when the workmen were astonished one day to see the piston travelling with unwonted rapidity.* Unable to account, upon any known principle, for what they had never seen before, investigation led to the discovery of the cause. The piston, in that age of the Steam Engine, was always covered with water, as the best packing then known to adapt itself to the irregularities of the bore of the cylinder; the means of boring the cylinder true, at that period being undiscovered. The piston was found to be pierced, by accident, in many places; through these holes the water found its way, and, falling upon the steam in a continued jet, condensed it with so much greater rapidity than by surface, that, from that day, condensation by surface was superseded, and, with the exception of some experiments tried by Mr. Watt, entirely suppressed, until its revival three

* See "Mechanics' Magazine," No. 882, p. 78.

or four years ago. This was the true origin, or rather the revival, of condensation by injection, Savery having previously used the jet in 1698. Condensing without the jet was long tried, in a variety of ways, by Mr. Watt; but it was, at length, abandoned on account of its inferiority. In a letter from him to Mr. Smeaton, dated the 24th of April, 1776, he thus speaks of his application of condensation by injection:—"I have made considerable alterations in our engine lately, particularly in the condenser, for which we have substituted one which works by an injection. In pursuing this idea, I have tried several kinds, and have at last come to one, which I am not inclined to alter, which operates beyond my ideas, in point of quickness and perfection." And the evident superiority of this mode, verified by time and experience, has borne ample testimony to the usual sound judgment of Mr. Watt; for, since his time, it has not been revived, until of late years.

Many attempts have since been made to prevent incrustation, by condensing without the usual jet; but although the plans hitherto adopted have been quite successful, so far as the mere prevention of incrustation and saving of fuel are concerned, yet they have been by the substitution of so many disadvantages; the best of them being by means so expensive, so complicated, so liable to derangement from the numerous joints, occupying so much valuable space, adding so much to the tonnage of the vessel, and taking so much from the effective power of the engine, as to render even incrustation preferable, in most cases, to such a remedy. The mere circumstance of a good vacuum being produced in the *condensers* of the non-injecting engines, can be no test of the effective power of the engine, or of the superiority of the plan. We must first ascertain the means employed, and, independently of the objections before mentioned, we shall find that two

extra pumps are necessary to keep up a stream of cold water in the cisterns, for the purpose of cooling the condensing pipes immersed in them, and at each stroke of the engine, a much greater quantity of cold water than would be necessary for an injection engine (2,500 gallons a minute for one of 500 horse power) must be forced through these tanks and pumped out again; for if it were not changed at each stroke, or nearly so, the condensing tubes would become too hot to effect a proper condensation. Thus all non-injecting engines must be burdened with such additional duty to perform, from which injecting engines are free; consequently the quantity of power thus uselessly expended deducts just so much from the *effective* power of the engine.

But, setting aside these deductions, it is important to ascertain, if we can, the real duty of an engine, by reference to its principles of action in the cylinder. It will not be disputed, by any one acquainted with the properties of steam, and the conditions upon which the greatest amount of *effective* duty can be obtained from an engine, that, other circumstances being the same, the due performance of this duty depends solely upon the piston in its ascent and descent meeting with no resistance from the steam on the other side of it. Highly elastic in its nature, and in its whole volume, if a particular method of condensing the steam is insufficient to absorb, or to annihilate the whole, on the *very instant* that the piston reverses its action, a portion of it will remain in the cylinder, and, still elastic, retard the piston in its progress, thus diminishing, by the resistance to be overcome, the available power of the engine. In order, therefore, to effect condensation by surface, it becomes necessary to have a surprising number of small tubes, making, indeed, many miles of pipes, as appears by the following details, extracted from No. 873 of the Mechanics' Magazine.

SURFACE CONDENSATION AS APPLIED TO		
	BRITISH QUEEN.	INDIA.
Diameter of cylinders . .	77½ inches	63 inches
Hall's Condensers	77½ inches each square, and 12 feet high	63 inches, exact shape and size of cylinders, 7 ft. 1 in. high
Miles of half-inch pipes in the two Condensers . . .	14	9
Number of joints in ditto .	14,000	9,000
Two extra force-pumps, to supply the Condensers .	Area 22½ by 17½, 3 ft. 8 stroke	Area 18 inches diameter, 3 ft. 10 stroke

A more minute investigation of condensation by surface, and by injection, than in any work on the Steam Engine, will be found in the same magazine; see Nos. 873, 882, and 900, and the other numbers therein referred to. The following extracts from No. 882, pp. 80, 81, are in confirmation of what has been previously advanced in these pages.

"If the steam in surface condensation were annihilated at top as instantaneously as it ought to be, to offer no resistance to the immediate reversal of the piston, it would be unnecessary to have the tubes nine feet long. But the moment the steam touches the top of the condensers they will be raised to a very high temperature, and be less capable of condensing the remaining portion with equal celerity; for the water surrounding the tubes cannot, with such pumps, be changed with the same rapidity as the injection water is removed, or rather cut off from its condenser, by the closing of the valves of the air-pump bucket. This steam must consequently remain at top until the first portion is condensed; and, though the time may be short, a very trifling difference in time makes a very great difference in the available power."

"A more perfect vacuum must necessarily be obtained by surface, but not in the same time throughout the whole space, and time is power in the Steam Engine. For similar

reasons a 27 vacuum by injection will give more real power than a vacuum of 30½ by surface."

"Objections to powerful machinery, on the score of complexity, will be found more valid the more they are considered and applied. Many illustrations could be furnished. There is a unity of design and a simplicity, which pervade all nature, and all great mechanical inventions, which render complexity a fatal objection at *the outset.* Wanting the power of perpetuity they want one of the chief criterions of excellence. The utmost efficiency is seldom or never attainable but by the utmost simplicity the particular invention is capable of, for simplicity and efficiency are the only sure characteristics of perfection. It may, perhaps, be considered an axiom in mechanics, that however completely a complicated invention may for a time appear to perform, either something will start up to prove it altogether worthless, or, if the end is indispensable, a subsequent inventor will simplify the means."

A preference has been given by some to condensation by surface, because they say, that the condenser may become choked in injecting engines, and that it is impossible to regulate the injection according to the speed of the engine. It will be seen that Symington's method of using the injection is *self-regulating;* and that, without any additional machinery, it possesses this singular and beautiful property, simply because there is no more pressure on the injecting water, or in the hot-well, than in the condenser itself. The drawing shows that the condenser air-pump and hot-well are so closely connected as to form one whole, by the medium of the condensing pipes. No part is open to atmospheric pressure, consequently no air is admitted with the injection. The little air, when separated from the steam, is expelled through a valve in the top of the hot-well, as soon as it becomes sufficiently compressed. The injecting pipe being

carried up level with the hot-well, before it enters the condenser, the water will remain the same height at each end, and will only move when the air-pump sends through the hot-well into the condensing pipes more than they can hold. Thus, out of what is withdrawn by the air-pump at each stroke, only the exact quantity required for injection will be thrown again into the condenser, and that in regular accordance with the speed of the engine, the rest escaping to the feed-pump, as described at page 13. Immediately the air-pump stops, the injection must necessarily stop also, there being then no motion, (or atmospheric pressure as in the common plan,) to continue it. The engineer need, therefore, neither turn the injection on, nor off, but just leave it to regulate itself.

I take the opportunity of these alterations, of observing, that several of these pamphlets were, through a strange mistake of an errand-boy, circulated at a public meeting, without the knowledge or consent of the writer. Being erroneous both in the drawing and the matter, every means has been used to recover them; and it is, therefore, expected that they will be returned by the possessors.

CHAPTER V.

EXTRACTS FROM REPORTS.—STEAM VESSEL ACCIDENTS.—EVIDENCE ON DESTRUCTION OF BOILERS, AND CAUSES OF EXPLOSION.—LOSS OF THE "FORFARSHIRE."—OFFICIAL LETTER TO LORD JOHN RUSSELL ON THE CAUSE.—AMERICAN REPORT ON CAUSES OF NINETY-NINE EXPLOSIONS.

THOSE only who are practically acquainted with the rapid destruction of the boilers from incrustation, and the consequent unnecessary consumption of fuel by the present system; or have gone through the evidence on the subject, in the several Reports by Committees in England and America, can sufficiently estimate the importance of an invention that will remove these effectual barriers to the universal employment of steam instead of wind power. The valuable evidence of engineers and practical men, embodied in the "Report on Steam Vessel Accidents," lately printed by order of the House of Commons, will, however, amply repay the time of perusal, and afford sufficient information on the subject.

In that Report it is stated, from the evidence on boilers, at page 14, "That they are very frequently continued in use till they become dangerously thin. We were shown several in the yards of engine and boiler makers, which (to use their own expression,) 'might be walked through;' indeed, the hand might be pushed through some boilers which we examined, but recently taken out of steam boats.—[See Mr. Laird's Evidence, page 64.] Mr. Shaw states, page 44, That the boilers of the 'Fingal,' in 1835, were so weak that they had to be shored between the deck and the tops of them, which

expanded and contracted like a pair of bellows. Captain Bain writes, page 89, That he has frequently had occasion, sometimes under very trying circumstances, to stop rents in boilers by temporary expedients; that he has witnessed it in other vessels, and has seen boilers worked till they were as thin as paper, &c. Some boilers, in actual use, are only kept tight by the deposit of mud, concretions of salt and sand, &c. between the flues; these obstructions to the passage of heat are not removed, as the metal of the boilers would give way, and they must necessarily undergo repair, which is delayed until they will no longer hold together, or until ruptures occur and have produced mischief.

"The explosion of deteriorated boilers is not the greatest disaster to be dreaded from steamers so ill provided; under the head of wrecks and founderings, the calamitous consequences of boilers failing at sea are still more fearfully exemplified."

Among other material evidence on the destruction and duration of the boilers, Mr. James Kennedy says, at page 63, "That the boilers are often worked after they have worn so thin as not to be trust-worthy, and generally not so frequently blown off and cleaned as they ought to be."

Messrs. Forrester and M'Gregor state, at page 65, "We have seen salt and sand accumulate in them to the depth of four feet between the furnaces, from not blowing off often enough."

Mr. John Laird, the eminent iron ship-builder, says, at page 65, "That he is in the habit of making and repairing a great many boilers for steamers; that he has seen them taken out of vessels in so worn a state that the hand could be pushed through them, consisting of little else than scales and rust; that the duration of an iron boiler may be called four years, it being useless to repair them after that term."

Captain Edward Chappell, R.N., of Her Majesty's Dublin

Mail Steam Packet Office, says, at page 69, "The horrible calamity which took place by explosion of a steam boiler at Hull, (the 'Union,' by which 24 persons were killed,) is supposed to have been occasioned by the engineer letting the water get too low in the boiler, which caused the generation of a highly explosive gas."

Messrs. Scott, Sinclair & Co. recommend, at page 85, for the purpose of guarding against explosions, that "above all, the masters take special care to see that their boilers have been carefully and well cleaned and examined."

Mr. C. W. Williams observes, at page 51, "How important a part the boiler of a steam vessel has to act, and that its giving way in heavy weather, or its general insufficiency, operates, in effect, in rendering every other part of the machinery utterly unavailable."

Steam Navigation owes something to this gentleman. Besides organizing a set of night signals, and superintending an efficient inspection of the fleet of steamers of the City of Dublin Company—no little merit in these days of Steam shipwreck and boiler explosions—he was the first to introduce iron water-tight divisions, to prevent steamers sinking from a leak; a humane and useful invention. He was also the first to construct an iron sea-going steamer, which seem destined completely to supersede wooden steamers, of whatever size, in those cases where the iron steamers can be kept constantly at work; for otherwise, their lying by may probably occasion a ruinous oxidation: but this only experience can determine. To continue Mr. C. W. Williams's Extracts from this Report would be unnecessary, since the rest of the evidence is to the same effect, that the explosions and destruction of the boilers arise from want of water and incrustation.

The melancholy loss of 45 lives, sent upon the moment to their last account, by the destruction of the boilers of the "Forfarshire," is still familiar to public recollection. If any

occurrence, connected with that fatal wreck, can make the catastrophe less painful, it is one of the noblest examples of heroism recorded among the daring deeds of heroic females —Grace Darling. Never be that name unrecorded!

In the official letter to Lord John Russell on the event, given at page 24 of this Report, is the following:—"Partial accidents from the explosion of steam boilers are constantly taking place; and only last week a steam boiler of one of the Newcastle and Shields boats burst, and occasioned the death of two individuals. These accidents are of so fearful a nature, and so constantly occurring, that it becomes necessary the government should be apprised of them, in order to institute inquiries that may lead to some measure which may be calculated to render steam boat navigation more safe to the community, and prevent the occurrence of calamities of such extended and fearful a nature."

The number of explosions down to 1839 were 23, and 77 persons killed. This is exclusive of lives lost through boilers failing at sea.

The evidence in that Report fully confirms the evidence given to Parliament upon Steam Navigation to India, (1834 and 1838) by Messrs. Field, M'Gregor Laird, and other engineers, by which it is proved in substance, that in sea-going vessels—owing to the incrustation by the salt water—the most difficult part of the machinery to keep in repair is the boilers; that, sometimes, they are injured as much in a few days, as they would otherwise be in as many years; that, in one case, a pair of boilers, made by Messrs. Bolton and Watt, gave way on their first voyage; that in consequence of this evil, the boilers are constantly requiring extensive repairs, even under the most careful management; and that in so short a period as four years, they must be entirely replaced. [See the Evidence on Steam Navigation to India, (1834;) particularly pages 61, 65, 76, and 103.]

The "Report to the Congress of the United States, on the number, nature, and causes of the disasters to steam boats," read in December, 1838, is not less conclusive. Out of the whole number of accidents, 99 were from explosions, occasioning the destruction of 500 persons; and, among the causes assigned, are "deficiency of water in the boilers, and omission to cleanse them frequently." In that Report it is observed, "In respect to explosions, the want of a sufficient supply of water in the boilers is believed to be the most plain, direct, and frequent cause of them. Smeaton and Watt, who made such vast improvements in the principles and the structure of steam machinery, appear to have both been fully aware of the danger resulting from an insufficient supply of water." And in the recommendations for legislative enactments, it is proposed, "That the boilers be cleansed periodically, or as often as once a month, under heavy penalties; as many explosions have occurred through sediment of salt and other substances collected within the boilers."

A remedy has been at length discovered, in Symington's method of continuing the *first* water in the boilers, that must, in a great measure, prevent these calamities, by removing the chief causes of their occurrence. Let it therefore be inquired into. Experience has placed its efficiency beyond doubt; and they will be responsible for the consequences, who neglect to apply the remedy, if proved effectual, and not found to occasion other disadvantages.

It only remains to show how it is that this plan saves so much fuel. Persons who have not made themselves acquainted with the depositions left by the evaporation of salt or impure river water, and have had no opportunity of seeing the thick crust, which adheres with so much tenacity to the boilers that it requires to be separated by the chisel, may probably doubt a saving in fuel so considerable as nearly one-third. The incrustation, however, is a very bad conductor of

heat; and, before the fire can act at all upon the water, it must pass through this substance, frequently considerably thicker than the boiler itself. The great quantity of heat thus uselessly expended, when spread over the extensive area of large boilers, might reasonably be expected to form a considerable portion of the whole. Experiment confirms it; for, independent of the incrustation, where the water is thickly saturated with salt, it will not boil under a temperature of 225°, instead of 212°, a difference of 13 degrees.

CHAPTER VI.

MR. FARRADAY'S EXPERIMENTS, AND EVIDENCE ON CAUSES OF DESTRUCTION OF MARINE BOILERS.—WASTE IN FUEL BY PRESENT SYSTEM EXPLAINED.—ANALYSIS OF SALT WATER.—DEPOSITIONS BY EVAPORATION.—SAVING BY USING FRESH WATER.

It was not until after the preceding observations were written, that I was aware of the inquiry government had made upon this subject. So early as 1822, when it was in contemplation to establish Post-office steamers, attention was particularly directed to this point, so great was the obstacle considered to the general employment of steam. Mr. Farraday's evidence confirms fully all that has been said, and explains the matter so clearly, that I persuade myself the comprehensive analysis of this eminent chemist will not be thought long or uninteresting. It was given before any remedy had been discovered for the evils complained of, and it is one of those fine instances of accurate investigation, which subsequent discoveries frequently confirm.

Mr. Farraday says, at page 180, "The principal source of injury to iron—arising from the salts contained in sea water, when they remain after evaporation—results from the presence of the salt called muriate of magnesia. When in solution it acts more on iron than its accompanying salts: and when dry it is decomposed at a heat of 270°, of Fahrenheit, and upwards, liberating muriatic acid; and this immediately acts upon the metal much more strongly than any other substance which the water contains; hence, besides the burning of the boiler, which takes place when the metal is coated by the

salts, there is this additional strong action from the liberation of the free acid, that it acts upon the metal by causing its oxidation, and forming a soluble salt with it; and it acts when in solution as well as when gaseous.

"Would the muriatic acid produce any effect upon the pipes, and parts of the engine connected with the boilers, through which the steam passes?—If the water were evaporated from the boiler, so that the salts should become dry on any part of it, and sufficiently hot, then the acid gas would pass into the steam passages and into the cylinder.

"Is the muriate of magnesia, you have described as existing in sea water, constantly acting upon the metal?—Yes; in experiments of four or five hours' duration, the solution of the salt was constantly acting upon the iron with which it was in contact.

"Is the injury considerable that this salt does to the metal?—Compared with that produced by equal quantities of the other salts in sea water, I should say four or five times greater.

"Does not the formation of the salt in crusts upon the bottom of the boiler, very much diminish the action of the fire upon the water in producing steam?—Certainly. Yes.

"If the force of the fire is not expended in producing steam in the degree it ought to do, supposing no such crust to exist, will not the degree of heat which ought to pass through the bottom of the boiler to the water, go along the flues, and thereby contribute to burn and destroy them?—Yes, supposing the flues are of materials to be injured by heat.

"In boilers containing large quantities of salt water, and giving steam for working engines, are those depositions of salt continually going on?—That will depend upon the water supplied to the boiler; *if the whole of the steam were condensed and returned into the boiler, there would be no concen-*

tration of the salt contained in it; but if there is a loss of steam, and sea water be supplied to the boiler in its place, a deposition of salt will take place, more or less rapidly, according to the loss of steam.

"It is in this way the concentration takes place of the body of water, which produces, in the result, these crusts upon the bottom of the boiler, which occasion so much injury?—Just so.

"Have you turned your attention to any remedy for the inconvenience arising from the use of salt water in steam boilers?—*If possible, the use of fresh water would remedy it; and, if that is not possible,* I would suggest the removal of the sea water in the boiler, before it be too much concentrated, and the supply of fresh portions of sea water, precautions being taken to supply them in such a state that they would do no injury, or cause any intermission to the working of the engine.*

"Are you acquainted with any instances of injury to the metal parts of the engines, arising from the use of foul fresh water, or water impregnated with earthy salts?—Every furred tea-kettle offers an instance of this kind of injury. In them the same process goes on as in many boilers in Cornwall. There are instances where considerable depositions of carbonate of lime have taken place in boilers, from the use of water containing calcareous matter. There are two specimens at the Royal Institution, of considerable depositions in pipes, from the passage of calcareous water through them; one of them being, I believe, the feeding-pipe to a boiler, and being nearly two-thirds choked with earthy matter—carbonate of lime.

* This evidence was given seventeen years ago; and it is not a little singular, that notwithstanding so many attempts have been made to discover a remedy, it should have been reserved for Mr. Symington to remove the only drawbacks to what his father first proved practicable.

"Has the cold salt water much influence upon iron?—Yes, it acts much more strongly than cold fresh water upon it.

"Could any chemical means be made use of to counteract the injury occasioned by the several salts contained in the boilers of steam engines using sea water?—I know of none to counteract the injury arising from the muriate of soda and muriate of lime; but I should think it probable that that arising from the presence of muriate of magnesia might sometimes be advantageously corrected, by the addition of either lime or the alkalies to the water, before it be introduced into the boiler. I suggest this merely from theoretical views; but such addition would produce other salts, though found by experiment not to be so injurious to the iron as the muriate of magnesia.

"What portion of water contained in the boiler may be raised into steam, before the salt is deposited?—About eight-ninths, not quite nine-tenths, before the salts are deposited.

"Do those salts, when decomposed, fasten strongly on the metal, or become incorporated with it?—I should think that would depend much upon the state of the boiler; they would, probably, in most cases, form hard crusts adhering to the bottom.

"Can those crusts be easily removed after the water is drawn off?—It is a hard crust, and would, probably, require considerable labour to pick it up.

"Do those crusts contribute considerably to prevent the proper application of the force of the furnace upon the water in the boiler?—They prevent, to a very considerable extent, the transmission of heat through the bottom of the boiler to the water, in consequence of their bad conducting powers as regards heat.

"Are they worse conductors than the metal itself?—Very much so.

"Can you state to the Committee what effect these crusts

have in the diminishing the making of steam, according to the quantity of fuel consumed?—*It would require considerably more fuel to raise the same quantity of steam*, but I am not able to give a proportion.

"Do these crusts contribute to hasten the burning of the bottom of the boiler?—Yes; by preventing the transmission of the heat through the bottom of the boiler, the metal itself becomes much hotter than it ought to be, and consequently burns away much sooner than it should do.

"By so much heat not being transmitted through the bottom of the boiler, it follows that the flues must become hotter than they ought to be, and thereby be considerably injured?—Yes."

Mr. Field, in his evidence, at page 155, given at the same time, says, in reply to the following questions:—

"Do you find any inconvenience in your engines, by the formation of salt in the boilers after the voyages?—Yes.

"Have you contrived any remedy for that inconvenience?—Nothing, excepting changing the water very frequently, and affording the greatest facility for that purpose to the engine-keeper."

And, again, at page 186:—

"Does not it require a very diligent attention, on the part of the engineer, to keep the engine constantly in good order?—Yes.

"What are the principal injuries that may arise from neglect on their part?—I think the greatest evil to be apprehended is to the boiler; their neglecting to feed it properly with water, and change it frequently.

"What is the consequence of that omission?—Burning the fire-place and destroying the flues.

"And also burning the boilers?—Yes."

Mr. Farraday, in addition to his evidence, from which the extracts have been taken, gave in a paper on a subsequent day to the Committee, containing the result of further and more accurate experiments. The following forms part of this interesting paper:—

"Royal Institution, May 7th, 1822.

"The following remarks are intended to accompany the evidence I have been called upon to give before the Committee, on Holyhead Roads.

"With regard to the composition of sea-water, the following numbers are very nearly correct, and accord with the best analysis. Its specific gravity varies, but may be estimated, as a mean, at 1027, pure water being 1000. When of a specific gravity of 1027.2, being such as I used in my experiments, one cubic foot of it weighs 1026.265 ounces avoirdupois, and contains—

	Ounces.
Common Salt	25.762
Muriate of Magnesia	3.282
Sulphate of Magnesia	2.212
Sulphate of Lime	1.013
	32.27

"When any of these salts, in their pure and separate state, are dissolved in water, and left in contact with iron, or are boiled with wrought iron in a close vessel, analogous to a steam-engine boiler, corrosion of the iron takes place, and an oxide of that metal is formed. The effect even takes place at common temperatures, and is much increased by the free access of air. In consequence of this power of corrosion, which belongs also to the solutions when mixed, as they are in sea water, all iron boilers, in which sea water is used, will be subjected to a much more destructive process than when fresh water is used in them, *notwithstanding any de-*

gree of care that may be given to them; and if care is not given, then other serious causes of injury arise, which greatly add to the bad effects necessarily attendant on the use of sea water.

* * * * *

"When a boiler, charged with sea water, is heated, and steam sent off from it, the following effects take place within: the water becomes more and more concentrated, acting at the same time more powerfully on the iron. When the concentration arrives at a certain point, the sulphate of lime begins to deposit, and forms crusts on the bottom and sides of the vessel. Continuing the evaporation, the water becomes so much diminished in quantity as to be unable to hold even the common salt in solution, and it begins to deposit. During the whole of this evaporation the temperature of the fluid has been rising, *and it requires more heat to make it boil than it did before.* Ultimately, if the operation be continued, the salts become dry in the boiler, the temperature rises, and when it attains from 270° to 300°, the muriate of magnesia is decomposed, its earth or magnesia left free, and its muriatic acid sent off in the state of gas.

* * * * *

"One bad effect produced by this state of things, is the burning of the bottom of the boiler and flues. The heat, in traversing the bottom of the boiler to reach the water, has also to pass through the crust of deposited matter, and, this being of bad conducting powers, obstructs its passage, and causes its accumulation in the metal itself, which, of course, suffers from combustion more rapidly, in proportion to the temperature: at the same time, the flame and smoke, not being able to give off their heat to the already heated metal, pass on into the flues, at a temperature far above what they ought to do, and burn them.

"Another evil is, that less steam is raised; for the crust,

acting as a barrier between the fire and the water, prevents the latter from receiving that accession of heat which it ought to do; and the quantity of steam produced is proportionably less. *Hence there is a waste of fuel in getting steam, or else there is a want of steam; and at the same time there is a burning of the boilers.*"

CHAPTER VII.

CONCLUDING OBSERVATIONS.—CERTIFICATES USELESS IF AT VARIANCE WITH PRINCIPLES.—PREJUDICE MUST BE REMOVED BY ANTICIPATING OBJECTIONS.—SUMMARY OF THE ADVANTAGES OFFERED BY THIS PLAN.—IMPORTANCE OF IT FOR STEAMERS DISTANT FROM ENGLAND.—SAVING OF NEARLY ONE-THIRD OF FUEL, EVEN IN RIVER WATER.—CRITERION OF PERFECT INVENTIONS, SIMPLICITY IN THE MEANS, EFFICIENCY IN THE END.—MR. WATT'S SEPARATE CONDENSER ANALOGOUS.—SYMINGTON'S INVENTION DOES FOR STEAM NAVIGATION, WHAT THAT DID FOR THE STEAM ENGINE.

It is very probable the writer may not have succeeded in convincing others, that this invention is of the same importance as he himself attaches to it. He has been, however, far more desirous of demonstrating, in the clearest manner, the simplicity and reasonableness of the invention, by entering upon—somewhat too much at length, perhaps—its mode of action, than of parading a long list of certificates. These are wholly unnecessary where the principle of an invention is evident to the meanest capacity, and consistent with experience; they are impertinent where they are not, for they then seek to choke you with their rubbish, advocating, upon incorrect data, the advantages of long forgotten and disused plans. There are too many instances of the insufficiency of these alone, to carry conviction. Who will believe them, if not in accordance with well known principles—the operation of laws, however modified in application, the same in practice? Prejudice must be removed, by leaving it no hold to cling to; that, if objections be then urged, they can be attributed only to sources which must render them unimportant.

As regards the present invention, the accumulation of facts in the numerous certificates, now separately printing, is evidence to those who desire them, that what was anticipated from the correct deductions of theory, has been fully confirmed by a long experience.

The writer has adopted, what seemed to him, the easiest and simplest course to bring it before the public. From a great mass of valuable evidence, he has extracted the opinions of the most experienced, to show the rapid destruction of the boilers, the great consumption of fuel, and risk of explosion; obstacles of no little magnitude to the universal substitution of steam for wind power, under the present imperfect system of Steam Navigation: he has explained the theory of the proposed remedy, in language stript of the technicalities of science, to show there is nothing in its principle to render failure probable; and then proved its operation by the evidence of facts. From these every one can draw his own conclusions.

Though at the risk of repetition, he will shortly enumerate what it is this invention has been found to effect, requesting the reader will bear in mind an important distinction:— that it is the only mode of preventing incrustation in operation, that involves no alteration of a principle well understood and universally adopted; that, in consequence, it deducts nothing from the proper duty of the engine, which requires no alteration to apply it. It has been found that, by constantly boiling and using the same water, the absence of the usual quantity of air in the condenser enables the engine to work better, producing more revolutions of the wheels; that the pressure of steam, as shown by the gauge, is always greater; that a good vacuum is maintained; that the boilers are kept perfectly clean; that they seldom require cleaning— never chipping; that the danger of explosion for want of

water is removed; that a saving of nearly one-third the fuel and tonnage is ensured; that the engine is kept in better order, by the oil and grease circulating through it, and lubricating the valves, these substances being never wasted; that the plan depends upon no complicated machinery for effective operation; that there are no numerous joints, subject to be expanded by steam, and contracted by cold, involving their getting out of order; that the cost is comparatively trifling; and that little time is needed for its application, being merely an appendage; that the pipes are as much protected as the keel of the vessel, and capable of being as securely fixed; that no accident that can happen to them alone, can delay the vessel a minute, as the Symington and common plan can be used alternately, separately, or combined, by the turning of a cock; and that a few spare pipes will enable any injury to be speedily repaired by the engineer of the vessel. It may also be fairly remarked, that there is no objection that a practical experience of two years has not proved groundless; and that, if there still remain a doubt in the minds of some, such doubt should not, in reason, prevent further inquiry, or be allowed to outweigh so many compensating advantages.

For steam boats destined for India, or any of its rivers, impure fresh water being found to be nearly as destructive to the boilers as salt; or for any country where its distance from England removes the facility of repairing them, this invention cannot be too highly estimated; for the saving in fuel, even in the Thames water, is found to be nearly a third. Experience does not yet enable the Patentees to state with accuracy, how many years longer boilers will last, constantly supplied with distilled instead of impure water; but as it is the depositions that are the chief cause of their destruction, if otherwise properly protected, the absence of any must

render their duration, without repairs, considerably greater. The difference, as at present known, in the duration of the boilers of the "Dragon" and the other tug, has been noticed at page 26. Mr. Thomas Wilson says, at page 61 of the Report on Steam Vessel Accidents, "As regards boilers, they are frequently worked till wholly worthless, and as thin as paper; and are neither reviewed nor repaired so frequently as they should be. The natural life of an iron boiler may be rated at about four years in the Mersey. Boilers have been taken out of steamers, having their water spaces blocked up with dirt and salt: four or five tons have been removed at a time." The writer has also frequently seen incrustations of an inch thick taken out of the Thames tugs.

Without claiming for this invention a degree of importance greater than its merits will justify, yet, looking at what it has done, it may, sometime hence, when prejudice shall be overcome, be considered the greatest improvement in marine engines, since the application of steam to Navigation. It effectually removes its great drawbacks; it has not been found to introduce any disadvantages to counterbalance them. The only proper criterion of every perfect invention is simplicity in the means, efficiency in the end; and these may be applied with much advantage in estimating their importance. Like the separate condenser of Watt—one of that great man's greatest discoveries—it effects by the simplest means the most important results, and does for Steam Navigation what that invention did for the steam engine, saving, when the relative state of machinery at the two periods is taken into account, as great a quantity of fuel. Like that, it is an addition, not an alteration, and is too simple in itself to attract notice; it wants the magnitude and complexity of machinery to excite admiration, until sufficiently estimated by the objects it effects.

If the facts stated in the preceding observations have been duly considered, it appears to the writer that little doubt can remain in the mind of every unprejudiced person, that the invention deserves, at least, investigation. If it be thought that the facts themselves have not been ascertained with sufficient accuracy to entitle them to implicit credence, and that trials under other circumstances might have produced different results; all the Patentees ask is, come and make what trials you please, that you may form your own opinion by the evidence of your senses.

It is reasonable enough, that every Proprietor of steam vessels should more readily trust to his own experience than to reports, however honest. In this case he has the opportunity of judging for himself, before adopting the invention. This plan permits, as was stated before, the old method to be used at any time after the application of the new; so that, by using the old and new plans alternately, say for three or four hours or a day each, the positive advantages of this invention, and the actual saving in fuel and boilers by its use, can be accurately ascertained. The "Dragon" has done for two years, and is doing every day, on the Thames, what has been stated; and every facility will be afforded for examination, by giving due notice to the Patentees.

You can then give the invention a trial upon one of your own vessels, without her detention, and at a comparatively trifling expense. Have everything ready to attach, and when any of your vessels is undergoing repairs, a few days will enable the pipes to be fixed. If the results of the trial on your steamer should be different to what it has been on all others, and contradict a two years' experience, your vessel is not delayed, because the old plan can be instantly resorted to: on her return take off the pipes, and where is the damage or great loss you have sustained? Your vessel

is just the same as she was, because no part has been altered for the trial. There are few inventions professing to do so much, that can be applied at so little cost or inconvenience.

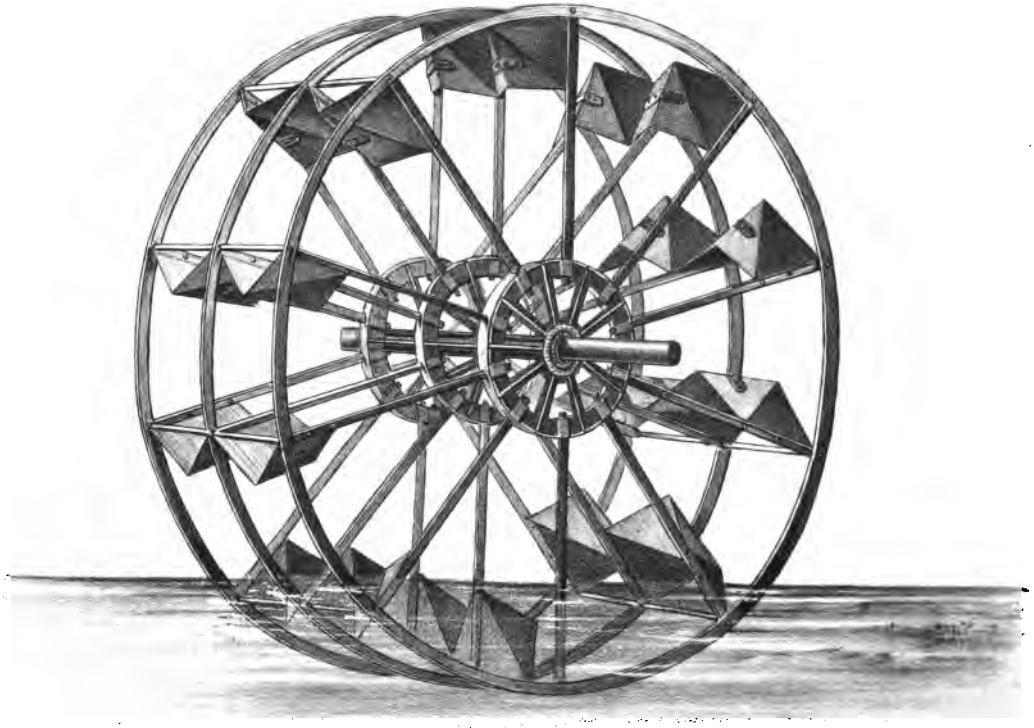
SYMINGTON'S

IMPROVED

FIXED PADDLE-WHEEL,

FOR

OCEAN STEAMERS.



SYMINGTON'S IMPROVED FIXED PADDLE WHEEL.

SYMINGTON'S IMPROVED

FIXED PADDLE-WHEEL,

FOR OCEAN STEAMERS.

NEXT to the incrustation of the boilers, no part of the machinery of the Steam Vessel more requires alteration, or has exercised more ingenuity, than the paddle-wheel.

It is surprising how many patents have been taken out, to protect what no one would be inclined to appropriate—improvements in the paddle-wheel, that exist only in the imagination of their authors. No object, perhaps, can boast a greater number of devotees; the patent list literally swarms with them. Professors of learned Universities, professors of unlearned Universities,* professors of all denominations, professors of everything, and professors of nothing, have equally contended for immortality, in a paddle-wheel. Some were made on strict mathematical principles, to solve some great problem in geometry and physics, with curves and angles "founded on data that could not err:" these were anything but a wheel of fortune, for, when tried, they pertinaciously stood still, or else run away from the engine. Others were made on no principle at all, giving full scope to imagination, which revelled *ad libitum;* and truly none but professed inventors could possibly invent anything so singular as some

* The "Verulam," to wit.

of them. If invention be a characteristic of genius, these gentlemen can boast, certainly, of a very large share of the divine gift. The most ingenious attempts at complication it is possible to conceive—annular rings—wheels within wheels —adjusting balances and tumbling bobs—eccentrics and revolving peculiarities, presenting friction enough to wear themselves out in no time, are the masterpieces of this class of inventors.

After all, for river navigation, where the line of flotation is always the same, there is, perhaps, none better than the common paddle-wheel; inasmuch as it can be nicely adjusted to enter and leave the water with the least possible loss of power, or strain to the machinery.

But it is far different at sea, where the rolling and pitching of the vessel plunges the wheel on one side axle-deep, whilst the other is performing its rotations more in air than water. The following evidence of C. Williams, Esq., extracted from the Report, in 1822, before made use of, will best describe, in the language of experience, the serious disadvantages of the common paddle at sea:—

"In what manner do the wheels operate to produce obstructions in the way of the proper speed and the power of the vessels?—The violent action of the paddles, in a heavy sea, striking the water, shakes and strains both the vessel and machinery, and produces what Captain Percy, of the 'Hero,' has very well described, as having a tendency to drive the top and bottom asunder; the result of this severe action is, that the engine loses its speed, and scarcely performs one-half or one-fourth of what it should do."

Mr. Symington's first paddle-wheel had moveable parts, and though the friction was reduced to a mere nothing, as will be seen by reference to the drawing of his horizontal windmill, which is the motion of the paddle-wheel reversed, too much objection existed to moveable paddles, to persevere

in its introduction; he therefore adopted the principle of the angle, but abandoned the motion.

The wheel now offered to notice, has lately undergone some alterations from practice, and may be seen at work in two tugs, "The William Symington," of 35-horse power, and the "Dragon," of 80-horse power. It has decided advantages over the common wheel, in preventing concussion, and acting more efficiently when deeply immersed, owing to the peculiar angle at which it enters and leaves the water.

It is nearly as cheap in its first cost as the common wheel, equally strong, not so liable to be injured at sea, and certainly cheaper to keep in repair. The following extract from a letter from the intelligent engineer of the "Dragon," to the Directors of the Company to which she belongs, will sufficiently prove its advantages for sea-going steamers. What has served so long the rough usage of a tug of 80-horse power, will answer any purpose:—

"I have now had to do with the Symington Paddle-wheels about twelve months, and during that time we have been several times round the Foreland, in very rough weather. We have been over to Holland, to Dunkirk, and in constant work towing, yet we have only had to get three new floats to replace those we had lost: and when the floats are joined as above, the wheel will be so firmly united together that none of the bolts will be liable to work loose; for the easy edge-ways entrance of this paddle into the water does not strain the wheel, nor shake the vessel, as the common float-boards do, by their striking the water with their whole surface flat-ways.

"You will remember that our vessel gained much credit with the parties concerned, by towing a ship out from among the ice, when none of the tugs having the common floats would venture to her assistance; and, should such a case occur again, I am convinced, from their easy action in a heavy

sea, that we should be able to show the decided superiority of the Symington Paddle-wheel over the common ones.

"I am confident that for ease of action, shown by the absence of that disagreeable vibration so much complained of, and the small expense of trouble or money, we may challenge comparison with any paddle-wheel in existence; and,

"I am your obedient servant,

"CHARLES MONTGOMERY,

11*th Nov.* 1839. "*Engineer of the* '*Dragon.*'"

SYMINGTON'S

PATENT

HORIZONTAL WINDMILL.

SYMINGTON'S

IMPROVED

FIXED PADDLE-WHEEL,

FOR

OCEAN STEAMERS.

RISE AND PROGRESS

OF

STEAM NAVIGATION.

RISE AND PROGRESS

OF

STEAM NAVIGATION.

CHAPTER I.

A BRIEF NOTICE OF THE RISE AND PROGRESS OF STEAM NAVIGATION.—HISTORY OF THE STEAM ENGINE NECESSARILY INVOLVED IN IT.—THREE PERIODS ONLY REQUISITE TO BE SPECIFIED TO CONVEY A GENERAL KNOWLEDGE OF MOST INVENTIONS: ORIGIN, FIRST IMPERFECT APPLICATION, AND GREATEST IMPROVEMENT.—HERO, OF ALEXANDRIA, 120 YEARS B.C.; MARQUESS OF WORCESTER AND NEWCOMEN, 1653 to 1705; WATT'S SEPARATE CONDENSER, 1765—THE THREE PRINCIPAL EPOCHS OF THE STEAM ENGINE.—ALL THE IMPROVEMENTS OF NINETEEN CENTURIES INSUFFICIENT TO RENDER IT A USEFUL MACHINE, UNTIL WATT'S INVENTIONS.—WATT THE GENIUS OF THE STEAM ENGINE.—ITS POWERS, AND WHAT IT HAS DONE FOR ENGLAND.—SIR WALTER SCOTT AND LORD JEFFREY'S EULOGIUMS.

A COMPREHENSIVE history of Steam Navigation would, unavoidably, embrace a detailed account of those improvements in the engine, which alone led to this application of it. Such an inquiry, however, would far exceed the scope of these observations. Nothing more is intended, as an introduction to its employment in navigation, than to notice, with as much

brevity as will distinctly mark its progress, the three principal periods of the Steam Engine:—

The earliest record with which we are acquainted;

The first and continued, though imperfect and limited, application to useful purposes; and

The chief improvements that gave to it its present capacity, and made it spread rapidly among civilized nations.

The first mention of what must certainly be called a Steam Engine, inasmuch as motion could be produced by steam, is the idea of Hèro, of Alexandria, 120 years B.C., and described in a work called "Spiritalia seu Pneumatica," under the name of the Œolipyle. Though it has no resemblance to the modern Steam Engine, it is a singular fact, that one of these identical Œolipyles, this ancient mummy of iron, after a sleep of nearly two thousand years, has been resuscitated, and was, not long ago, and probably is at this time, at work in America, under the name of Avery's Rotatory Engine.

Upon the authority of the original Records of the Royal Archives of Simancas, department of Catalonia, it is stated, that a Spaniard, Blasco de Garay, propelled, by steam, "La Trinidad," of 200 tons, in the port of Barcelona, on the 17th of June, 1543, in the presence of Charles V. The Spanish nation is therefore clearly entitled—assuming the authenticity of the record—to the honour of first applying steam to useful purposes; as also to navigation. It is, however, much clearer, that this honour is remarkable chiefly because it stands alone, for it led to nothing; the Spaniards neither continuing its use, nor adding a single improvement at any period of its progress.

From the early period, therefore, of Hero, until the Marquess of Worcester's engine, erected in 1653, to supply the inhabitants of Vauxhall with water, and which, on the 28th

of May, in that year, was seen in operation by Cosmo de Medici, the Steam Engine can be considered in no other light than as a mere philosophical toy; showing, however, even at that time, its power, though not its docility. This, probably, was the first Steam Engine ever continuously used in this country, or elsewhere: though Sir Samuel Morland is generally considered to have erected the first in 1683. Branca, an Italian, in 1629, suggested the employment of steam to produce motion; but the machine described is simply the Œolipyle: he, therefore, deserves even less honourable mention than Hero.

In 1682, Papin, a Frenchman, invented the safety-valve; and, in 1690, the piston, and method of producing a vacuum by condensing the steam in the cylinder: great advances unquestionably; the foundation, in fact, of the present Steam Engine. His idea of the combination was, nevertheless, rude to a degree. He did not use, even in his experiments, a separate vessel to generate the steam, but applied the fire direct to the cylinder, as will be noticed by and by, when speaking of the different methods of condensation; and, of the extreme importance of the piston he was certainly unconscious, for he not only did not use it, but entirely abandoned it, for an engine of similar construction to that of Savery's.

In 1698, Savery obtained a patent for his steam engine, called the Miner's Friend, though it was not adopted, as implied by its name. He was the first to employ for useful purposes the vacuum resulting from condensation of steam; but even Savery used no piston.

It was at this period that the Steam Engine began to attract more general attention, and occasionally to present abundant evidence of what it might one day become, when a mind should be found powerful enough to give it a safe and useful direction. But it was not until Newcomen's engine, in 1705, that this useful machine deserves much notice or admiration.

Prior to that period it was employed to a very limited extent to raise water. This was effected, not by the rise and fall of the piston, as at present, but by the pressure of the atmosphere upon the water intended to be raised, forcing it up the connecting pipe into a receiver, previously exhausted by the condensation of steam producing a vacuum in it. When the water was got up this distance, limited—owing to an imperfect vacuum—to a rise of about 26 feet, (instead of 34 feet, the height of a column of water sustained in a perfect vacuum by atmospheric pressure,) it was prevented returning by its weight closing the valve, which opened upwards at the bottom of the receiver, through which it had just been forced by the atmosphere. The steam was then let into the receiver, and, by its pressure upon the water therein, caused it to rise through another pipe to the place intended. This could not be more than 68 feet above the receiver, because steam was not, at that period, obtained to exert with safety a greater pressure than 45 lbs. on the square inch. A valve in this pipe, also, opened upwards, and thus prevented the return of the water, by closing with its weight. The steam having thus emptied the receiver, was again condensed by cold water flowing upon the outside, which, causing the vacuum as before, it was immediately followed by the rush of water from the well into the exhausted receiver; and thus the same process continued.

It is apparent, therefore, that to drain deep mines with an engine of this description, several must be employed one above the other, at distances of about 94 feet; 26 feet being, as just described, the height to which atmospheric pressure was equal to force water from the mine into the partially exhausted receiver; and 68 feet being the extent to which it could then be continued above the receiver, by the highest pressure steam that could be safely exerted.

This engine has not been noticed to combine the low and

high-pressure principles, though reversed as regards the latter. Condensation of the steam sufficiently identifies it with the low-pressure engine; but instead of steam being driven into the atmosphere, as in the high-pressure engine, the water in Savery's engine is raised from the receiver, in opposition to atmospheric resistance. This accounts for the narrow limit to its power, because 15 lbs. steam pressure per square inch on the water to be raised from the receiver, is expended merely to equalize the atmospheric resistance to its ascent; consequently, the water will not be raised an inch by such pressure; all above it, however, is available power: for instance, 15 lbs. will only neutralize atmospheric resistance; 15 lbs. more, or 30 lbs. in all, will raise a body of water from the receiver, having a base equal to the surface pressure, 34 feet high; 45 lbs. pressure will raise it 68 feet high, and so on. If, therefore, 15 lbs. be deducted from the total pressure exerted, the remainder will show to what height a column of water can be raised, by allowing 34 feet for every 15 lbs. pressure.

The consumption of fuel by such an engine was necessarily enormous. The steam coming in immediate contact with the water to be raised from the receiver, was partly condensed before it could exert any pressure. To separate the two, a piece of wood, which may be considered a rude sort of piston, was interposed, fitting exactly to the shape of the receiver, and floating on the water in it, and thus some fuel was saved.

Newcomen's improvements on the Steam Engine, form by far the most important feature in this, the second, era of its progress. He first employed the piston to communicate motion, one of the greatest steps to its future usefulness, and which gave to it the form and character that, not long afterwards, led to its being perfected by a single mind. Until Newcomen's engine, none bore any resemblance to the mo-

dern, in shape or principle. The many great disadvantages of the Steam Engine, prior to his time, the ruinous expenditure of fuel, its childish powers, compared even with that of Newcomen's, and the limit to its extension, caused such engines to fall into disuse. The application of the beam and piston, however, changed it immediately from a very limited employment to a much wider field of usefulness. And this, Newcomen effected.

The third, and most interesting, and, for generally useful purposes, the only important era of the Steam Engine, was the period of those grand improvements of Mr. Watt, that made it rank as one of the noblest inventions of any age or country.

Previous to Mr. Watt's earliest and most valuable discovery —the separate condenser—in 1765, Newcomen's engine had been pretty generally employed in Cornwall—the first and great field for the exhibition of all improvements on the Steam Engine—to draw water from the mines; but its adaptation to the delicate machinery of manufactures was not imagined, owing, probably, to its total inapplicability. It was worked by the pressure of the atmosphere on the piston, a vacuum being produced beneath it, by condensing the steam in the cylinder itself. This was obtained by turning on a stream of water between the cylinder and its casing, called a jacket. When the stroke was completed by the descent of the piston, steam was admitted underneath it, to force it up against atmospheric resistance, aided by the counterbalance of the pump rods at the other end of the beam. The consumption of fuel was, however, ruinous to some of the mines where it was employed. Such was the state of the steam, or rather atmospheric engine, just previous to Mr. Watt's beautiful inventions. Being open at top there was necessarily a limit to its powers, however large the diameter; for no stronger

pressure on the piston could be obtained from the atmosphere than 15 lbs. on every square inch.

Condensing the steam in a separate vessel, instead of in the cylinder; enclosing the cylinder at top, that steam might act upon, as well as under the piston, instead of allowing the atmosphere to force it down, as before; the application of the mill-governor to regulate the speed of the engine; and the parallel motion, were Mr. Watt's chief improvements: turning what was an atmospheric engine, into a complete double-acting steam engine; and making it applicable to supply every want that the numerous luxuries of a great and civilized nation might create. After encountering the usual prejudice, and being involved in litigation in defending his claims, Mr. Watt's engine returned many thousands a year to its illustrious author; but not before £50,000 had been expended, and ten years of the patent expired, in bringing it into use.

It will be seen by the few observations at pages 29 and 32, upon the comparative advantages of condensation by surface, and by injection, that the manner in which the steam was condensed, must, at each period, have had a great control over the advancement of the low-pressure engine. It is, in truth, the different methods of condensation that mark most distinctly the different eras of its progress; for we find, that as this became more perfect, the effective duty of the engine kept pace with it, and the demand for them increased.

From the rudest method to the perfect condenser of Watt, the advance was gradual, and not uninteresting to notice. The contrast exhibits even greater difference than between the tardy and uncertain spear of the savage, and the quick and unerring percussion gun of modern art: the former requiring the strength of the savage, the other more certain in the hands of a child. Analogous were the two extremes of condensation.

Papin's method of condensing the steam—the earliest with which we are acquainted—is explained in the "Actæ Eruditorem," of 1690. Fire was to be applied beneath the cylinder, in which was water between it and the piston; the steam produced raised the piston; the fire was then withdrawn, and the tedious process of the atmosphere cooling or condensing the steam was necessary, before the piston could descend. This idea, however, does not appear ever to have been tried. Such an engine was, in fact, barbarous, and possessed little, if any power.

Savery, in 1698, obtained a vacuum by condensing the steam by throwing cold water on the surface of his receiver; but finding this tedious, he let water into it. The engine was improved, and its power increased.

Newcomen, in 1705, surrounded his cylinder with a jacket, and turned between the space a stream of water, when condensation was required, until accident discovered condensation by injection, in 1711, before described at page 29. The engine then first began to be generally employed, its greatly increased power rendering it applicable to drain mines.

Watt, in 1765, invented the separate condenser, using the injection jet, after giving up surface condensation. This improvement saved at once three-fourths of the fuel; the engine then became perfect in the principle of condensation, and its power unlimited.

These gradual advances to perfect condensation are full of interest. They mark the slow growth of improvement, collecting the intellect of nearly a century to arrive at maturity. Compare the tedious and barbarous process of the first, with the lightning rapidity of the last; the precision and certainty with which the injection-jet seizes hold of the steam, and reduces it into water as instantaneously as an explosion. Papin, in describing his method of condensing, says three

strokes a minute may be obtained by this plan; twenty-five, thirty, or more, according to the size of the engine, are now the usual number per minute.

We admire contrivance in proportion to our acquaintance with difficulties overcome; and it is a knowledge of the defects of Savery's, and the atmospheric engine, that enables us to contemplate with more admiration those miracles of simplicity, by which the greatest obstacles were removed, and yet were the conceptions of one man.

Did it come within the intention of these observations, it would be, doubtless, an interesting and curious inquiry, to trace more minutely the rise and progress, and gradual improvement of a power, which has produced so wonderful a revolution in commerce and manufactures; which has taken nearly two thousand years to bring to maturity, receiving the tardy contribution of centuries as they rolled onwards, chiefly from comparatively poor understandings, and passed unnoticed or unimproved by the highest order of intellects.

It would, however, but fill up the outline, and furnish additional evidence, that the various alterations or additions of so many years were for the most part useless, until the master-mind appeared in our own time and country, and poured out all his genius upon the huge and uncouth mass, giving a form, and order, and beauty to its various proportions, until it rose, almost by magic, under the power of his thought, into one perfect combination. Immediately the brilliant idea of the separate condenser flashed across his mind, his other great improvements followed each other in rapid succession, so that in a single day was perfected the wonder and admiration of ages.

It was Mr. Watt alone who made each part perform, with marvellous regularity and infinite precision, its allotted duty, without confusion and without noise; obliged to perform it,

but incapable of exceeding, by almost a hair's-breadth, the course appointed it to run; uniting unlimited power with a delicacy of touch only equalled by the blind; the whole machine endowed with a never-dying capacity that will exist coeval with the elements from which it derives its existence; and yet so manageable, that at this time, under the guidance of a child, it is all but omnipotent, and harmless as powerful. Drawing rivers of water from the deepest mines, heretofore inaccessible to human skill, whilst it is more than a substitute for thousands of beings, by performing labours they could never execute, it gives, at the same time, employment to hundreds who, but for its ceaseless operations, would be idle. Collecting information from nearly every part of the globe, and concentrating it into one focus, only to spread its rays more extensively, and with greater power, it circulates, through the press, for fivepence, to millions in distant kingdoms, a knowledge of the affairs of all governments, and of all that can interest and instruct. Making new data for mankind to estimate space and time, and holding the hitherto impracticable elements in dominion, it is rapidly spreading over all nature, and in its passage to nations, makes the vast fabric it drives onward,

> —— Walk the waters like a thing of life,
> And seem to dare the elements to strife.

It would be difficult, perhaps, to enumerate all the benefits Mr. Watt's inventions have conferred on the human race, or to estimate in particular the resources they have rendered available to his country. But for his steam engine half of the mines in Cornwall would be abandoned, and we should be dependant upon other nations for our large consumption of copper and tin. Great capitals would be diverted from our soil, and thousands of those intelligent miners, and their well-conducted and industrious families, who now find

ready subsistence from such works, would have to seek occupation elsewhere. No concentration of power of any number of horses could succeed in draining mines from one to two thousand feet deep, and which alone enables them to be profitably worked, or worked at all. The national obligation, at the commencement of the French war, in 1793, was only £239,350,148, and Hume, Blackstone, Adam Smith, and other political writers prior to that time, despondingly predicted the downfall of our greatness in one hundred more millions of debt. It was Mr. Watt who supplied the six hundred and one millions to carry on the war, and enabled Great Britain to support the burthen. The application of his steam engine in 1790, the year it was first applied, to the delicate cotton machinery alone, has contributed, in connexion with Arkwright's improvements, to raise the importation of cotton from 31,447,605 lbs. in that year, to 411,286,783 lbs. per annum, affording freight to 300,000 tons of shipping, and employment to two millions of people. The value of the cotton, when manufactured, being estimated at fifty millions a year, is further evidence of the powers of the steam engine.*

If we turn to what it is doing in navigation, we find—with deep obligations to Symington, who gave it the momentum —that a power equal to 63,250 horses is employed in England alone, in driving onward 157,993 tons of shipping, in opposition to the elements: and, making a minimum calculation, from accurate data, of the steam power employed in Great Britain for various purposes, we may fairly estimate, that by its wonderful operations it saves the labour of seven mil-

* Sir Richard Arkwright was a poor barber. He substituted rollers for fingers in drawing the cotton; and left his children £100,000 a year. Wyatt, however, was as much the inventor as Arkwright, and is entitled to priority.

lions of men, and an expenditure of twenty millions sterling a year. These figures perplex and fatigue the mind by their magnitude, but the data which trace such stupendous results to one individual are simple and accurate; they are the dumb, but most eloquent memorials of a greatness that will not pass away.

It is not, however, as the greatest machinist alone that we must estimate Mr. Watt. M. Arago has lately awarded a fresh laurel to his memory, as the first who ascertained the composition of water, in 1783—an honour previously given to Cavendish. The name of Watt must also be associated with that of Dr. Black, in the great discovery of latent heat, in 1762.

Nature does not, perhaps, present any operation to our investigation more remarkable than that of latent heat; heat that lies hid—that cannot be discovered by the most sensitive thermometer. The following processes will illustrate the principle:—Two pounds of water at 32°, the freezing point, incorporated with two pounds of water at 166°, will produce the mean temperature of 99°. This is reasonable. But dissolve two pounds of ice, the temperature of which will be found to be only 32°, the same as water at the freezing point, with two pounds of water at the former temperature of 166°, and the temperature of the whole will not exceed 32°. Again, send two pounds of steam at 212°, the boiling point, into ten pounds of water at 32°, and the whole will be raised to the temperature of 212°; but if made to incorporate itself with ten pounds of ice at 32°, the whole will not exceed the temperature of 32°. Neither the most sensitive touch, nor the most accurate thermometer, can detect the greater degree of caloric in the water than in the ice. Both indicate the same temperature; therefore it lies hid, and is called latent heat. Yet these penetrations into the great mysteries of nature, important as they undoubtedly are, formed but a small por-

tion of those vast stores of learning of which he was so prodigal, reached only by extraordinary grasp of intellect, and mastered but by equally comprehensive powers of arrangement.

"The variety of the knowledge of our associate," says M. Arago, in his honourable *éloge* of Mr. Watt, "would have been absolutely incredible, were it not attested by many eminent men." The late Professor Robison says, "I had the vanity to think myself a pretty good proficient in my favourite study, and was rather mortified at finding Mr. Watt so much my superior. He learnt the German language in order to peruse Leopold's 'Theatrum Machinarum;' so did I, to know what he was about. Similar reasons made us both learn the Italian language. Mr. Watt was the first to ascribe to the ingenuity of a friend, things which were nothing but his own surmises, followed out and embodied by another. I am the more entitled to say this, as I have often experienced it in my own case." "It is for you, gentlemen, to determine," justly remarks M. Arago, "whether it was not as honourable to have expressed this concluding sentiment, as to have inspired it."

To gauge, indeed, the talent of one so remarkable for intellectual endowments, we must take a standard of which England presents, at this time, scarcely a parallel. Yet it is only by comparison we can estimate the richness of an intellect, which ordinary description is insufficient to convey. Knowledge so varied, yet so profound; a mind so extended, yet so vigorous; and, in his own particular department, so immeasurably superior to the highest talent for mechanical invention and combination with which we are acquainted, we are at a loss which most deserves our admiration and wonder —the great range and exactness of his researches—the magnitude of the power he has created—its precision and delicate

application—or the simplicity of the means by which he has enforced its continuance.

Having departed in some measure from the chief object of these observations, a little further wandering may not be minded, if it lead to some of those brilliant encomiums on Mr. Watt, which offer sufficient interest in themselves to be acceptable in any pages. They are not irrelevant here. A laudable curiosity seeks gratification in learning the extent of the mental powers of a man who has left these enduring records of his fame. It is not generally known that he was much more than the improver of the Steam Engine; an error that will be seen by the opinions of two of the many celebrated cotemporaries by whom he was surrounded.

Sir Walter Scott, in his Preface to the "Monastery," speaking of this great man, in his usual language that throws a charm over all it embraces, says, "There were assembled about half a score of our Northern lights; amidst this company stood Mr. Watt, the man whose genius discovered the means of multiplying our national resources to a degree, perhaps, even beyond his own stupendous powers of calculation and combination; bringing the treasures of the abyss to the summit of the earth; giving the feeble arm of man the momentum of an Afrite; commanding manufactures to arise, as the rod of the prophet produced water in the desert; affording the means of dispensing with that time and tide which wait for no man; and of sailing without that wind which defied the commands and threats of Xerxes himself. This potent commander of the elements—this abridger of time and space—this magician, whose cloudy machinery has produced a change on the world, the effects of which, extraordinary as they are, are perhaps only now beginning to be felt—was not only the most profound man of science, the most successful combiner of powers and calculator of numbers, as adapted to

practical purposes—was not only one of the most generally well informed, but one of the best and kindest of human beings. There he stood, surrounded by the little band I have mentioned, of Northern literati; men not less tenacious, generally speaking, of their own fame and their own opinions, than the national regiments are supposed to be jealous of the high character which they have won upon service. Methinks I yet see and hear, what I shall never see or hear again. In his eighty-fifth year,* the alert, kind, benevolent old man, had his attention at every one's question, his information at every one's command.

"His talents and fancy overflowed on every subject. One gentleman was a deep philologist—he talked with him on the origin of the alphabet, as if he had been coeval with Cadmus; another a celebrated critic—you would have said the old man had studied political economy and belles-lettres all his life: of science it is unnecessary to speak—it was his own distinguished walk. And yet, Captain Clutterbuck, when he spoke with your countryman, Jedediah Cleishbotham, you would have sworn he had been coeval with Claverhouse and Burley, with the persecutors and persecuted, and could number every shot the dragoons had fired at the fugitive Covenanters. In fact, we discovered that no novel of the least celebrity escaped his perusal, and that the gifted man of science was as much addicted to the productions of your native country, (the land of Utopia aforesaid,) in other words, as shameless and obstinate a peruser of novels, as if he had been a very milliner's apprentice of eighteen."

Lord Jeffreys, in an eloquent article on Mr. Watt, in the Supplement to the "Encyclopædia Britannica," pays the following tribute to his surprising talent:—"Independently of his great attainments in mechanics, Mr. Watt was an ex-

* Probably a misprint: Mr. Watt died in his 83rd year.

traordinary, and in many respects a wonderful man. Perhaps no individual in his age possessed so much, and such varied and exact information; had read so much, or remembered what he had read so accurately and well. His stores of miscellaneous knowledge were immense, and yet less astonishing than the command he had at all times over them: it seemed as if every subject that was casually started in conversation, with him had been that which he had been last occupied in studying and exhausting; such was the copiousness, the precision, and the admirable clearness of the information which he poured out upon it without effort or hesitation. Nor was this promptitude and compass of knowledge confined, in any degree, to the studies connected with his ordinary pursuits. That he should have been minutely and extensively skilled in chemistry and the arts, and in most of the branches of physical science, might, perhaps, have been conjectured; but it could not have been inferred from his usual occupations, and, probably, is not generally known, that he was curiously learned in many branches of antiquity, metaphysics, medicine, and etymology; and perfectly at home in all the details of architecture, music, and law. He was well acquainted, too, with most of the modern languages, and familiar with their most recent literature. Nor was it at all extraordinary to hear the great mechanician and engineer detailing and expounding, for hours together, the metaphysical theories of the German logicians, or criticising the measures or the matter of the German poetry. He generally seemed, indeed, to have no choice or predilection for one subject of discourse rather than another; but allowed his mind, like a great cyclopædia, to be opened at any letter his associates might choose to turn up; and only endeavoured to select from his inexhaustible stores, what might be best adapted to the taste of his present hearers."

Lord Brougham, Sir James Mackintosh, Mr. Huskisson,

Sir Humphrey Davy, Sir Robert Peel, M. Dupin, M. Arago, and many others, have all joined in similar panegyrics, exaggerated as they appear. It would seem, indeed, all but impossible that one mind could justify these descriptions, coming, too, from persons themselves so remarkable. Yet, to enumerate the historians, philosophers, and statesmen, who have united in calling him greatest, and in depositing the crown of *perpetuelles* on the monument of Mr. Watt, would be to record the most illustrious names of England and France. An empire has grown great by his discoveries; he has left the resources of greatness to others, and nations have joined in friendly rivalry of admiration and gratitude to the greatest benefactor of mankind.

On the 18th of June, 1824, one of the most illustrious assemblages of talent that, perhaps, was ever known for a similar object, met to do homage to the genius of Mr. Watt, by erecting a monument to his memory in Westminster Abbey.

This, doubtless, was owing to an eloquent Frenchman, Baron Dupin, who first roused the apathy of this country, in the following passage of his "Commercial Power of Great Britain," read to the French Institute, on the 2nd of June, 1823. Speaking of him as "the greatest honour to England," he observes, "Watt is one of England's best benefactors, and brightest ornaments. I asked, with much eagerness, what brilliant reward he had received from the gratitude of the nation?—and my question remained unanswered. It should seem that not the king, nor his ministers, nor the parliament, could discover anything worthy of commemoration in the life or memory of a man, to whom the ancients would have erected statues and altars, as they did to Triptolemus, the

inventor of agricultural improvements. The ashes of Garrick, the performer, repose under the sacred roof of Westminster Abbey; and the ashes of Watt lie in the obscure retreat of some unknown burying ground."*

Excepting M. Dupin and M. Arago, all were present whose names have been mentioned. Party feeling was forgotten: the strife of politics was laid aside, whilst the congregated talent of London united in recording the gratitude of their country to him whom they all allowed superior. It is to be regretted that the eulogiums of such an assemblage have not been preserved, but in the limited half-column of a newspaper.

The king, with accustomed liberality, sent, by his ministers, a cordial concurrence with the object of the meeting, and £500 to promote it. Sir Robert, then Mr. Peel, nobly declared that he owed everything to Mr. Watt—family, wealth, and honours—that his steam engine had done all.

Whether it is that France and Italy pay more respect to the memory of their illustrious dead, on account of the rarity; or that foreigners may best learn the history of these countries by reading it in the numerous statues they see around them; or whether they think such memorials of past greatness are the best incitement to future generations, it is certain this country requires more stimulus to record its gratitude to its own. Newton—whom Dr. Johnson said would have been worshipped as a Deity in ancient Greece—Nelson, Byron, and Scott—and which name is wider spread it would be difficult to say—yet remain to be so recorded; not shut up in Westminster Abbey, but to meet us in some commanding situations.

* Baron Dupin has entered fully upon the services rendered by Watt to mankind, in his "Considerations sur les avantages de l'industrie et des machines, en France et en Angleterre," delivered to the Institute of France, in April, 1821.

It is somewhat singular, that one so remarkable in life as Mr. Watt, should, at his death, unite in the record to his memory, so rare a combination of talent. The following epitaph is written by Lord Brougham, graven on a monument sculptured by Chantrey, to commemorate the genius of Watt:—

NOT TO PERPETUATE A NAME,
WHICH MUST ENDURE WHILE THE PEACEFUL ARTS FLOURISH,
BUT TO SHOW
THAT MANKIND HAVE LEARNT TO HONOUR THOSE
WHO BEST DESERVE THEIR GRATITUDE;
THE KING,
HIS MINISTERS, AND MANY OF THE NOBLES
AND COMMONERS OF THE REALM,
RAISED THIS MONUMENT TO

JAMES WATT,

WHO, DIRECTING THE FORCE OF AN ORIGINAL GENIUS,
EARLY EXERCISED IN PHILOSOPHICAL RESEARCH,
TO THE IMPROVEMENT OF
THE STEAM ENGINE,
ENLARGED THE RESOURCES OF HIS COUNTRY,
INCREASED THE POWER OF MAN,
AND ROSE TO AN EMINENT PLACE
AMONG THE ILLUSTRIOUS FOLLOWERS OF SCIENCE,
AND THE REAL BENEFACTORS OF THE WORLD.
BORN AT GREENOCK, MDCCXXXVI.
DIED AT HEATHFIELD, IN STAFFORDSHIRE, MDCCCXIX.

CHAPTER II.

APPLICATION OF STEAM TO NAVIGATION.—DIFFICULTY IN ASCERTAINING THE REAL AUTHOR OF AN INVENTION.—CAUSES.—HARD FATE OF INVENTORS.—CHAMBERS' EDINBURGH JOURNAL AND THE LATE MR. SYMINGTON.—MR. SYMINGTON THE REAL INVENTOR, BY FIRST PROVING ITS PRACTICABILITY.

To rescue the brilliant thought of genius from the grasp of rival candidates, or to search it out from amidst accumulations that would prevent its discovery, or obscure its rays, in order to restore to its rightful owner the honour of an invention which too many would deprive him of, is the duty of all who profess to treat of the rise and progress of a science. Yet it too frequently happens that the labour of research, the carelessness of investigation, the pride of country, or the partialities of friendship, prevent those minute inquiries which would lead to a discovery of the truth; and thus the memory of the dead is deprived of the only honours that remain to be paid.

Fate, or Providence, seems to reserve an accumulation of ills for the talented, but poor inventor. It does not seem enough, that the man who has passed a life of hope and despondency, subject oftentimes to many privations, in seeking to perfect what may, in its results, control the resources of a nation; spending, as too many have done, all they possessed, in bringing it just to the state that enables one more wealthy to seize it—should live neglected and die in poverty. Considered by many an enthusiast before his time, or a fool after it, even at his death the merit of his invention is too fre-

quently claimed by others, and confirmed by the careless or partisan inquirer. Truth, however, is the heir-loom of posterity; and though the inheritance may, occasionally, be wrongfully enjoyed, time seldom fails to vindicate his memory, and give evidence of the simple beauty of the saying, "Magna est veritas et prevalebit." This maxim speaks so forcibly, that it is felt to be true, and remains the consolation of all who have been wronged, that, sooner or later, they will have justice done to them.

The history of inventions and their authors, records few to whose fate these observations apply with more truth than to the fate of him who, a cotemporary of the great Watt, and the friend of the adventurous Bruce, first proved the practicability of steam navigation—the late William Symington.

That many should claim the honour of the first practical application of a power, which has added so incalculably to the convenience and happiness of mankind, was to be expected from the important results that have followed; but that the late William Symington was, in fact, the earliest who, in this country, directed public attention to Steam Navigation, by the first efficient steam boat, there can remain no doubt, when the evidence is impartially considered.

Whatever may be the talent, or however numerous the authorities on the other side, these ought not to stop inquiry at the threshold. It is to be regretted that a periodical of the extensive circulation of "Chambers' Edinburgh Journal," conducted with ability, and admirably combining the useful with the amusing, should have supported, upon a foundation so slight, without further inquiry, the pretensions of the late James Taylor, whose widow is now in the enjoyment of a pension from government—a reward for the services of her husband, as the supposed inventor of Steam Navigation.

If it requires us, as individuals, for our own happiness and prosperity, as well as to enable us to deal justly towards

others, to be accurate in our investigation of facts, and honest in relating them, this requisition becomes a duty of a very high order, in the editors of a periodical publication, devoted, like that of Chambers', to convey instruction derived from authentic sources. A large sheet of knowledge, thrown off with the prodigality of intellect and steam, enables them, for three-halfpence, to sow, broadcast, truth or falsehood, to thousands every week, and thus to do more injury at one publication, than can be repaired by other means for a long series of years. The examination of *exparte* evidence is insufficient in all cases. A wise and unprejudiced man will give a cautious assent to such testimony: he will judge of the animosities and jealousies of his relator, and not risk his character and judgment in a conclusion, that further inquiry may prove erroneous. If a journalist observes not this caution, he will frequently deceive his readers and injure the real inventor.

In my inquiries to do justice to the memory of the man, whoever he might be, who had first proved the practicability of Steam Navigation, I was told by the family of Mr. Symington, that the editors of "Chambers' Journal" had been called upon to produce the evidence they referred to, upon which they had given the merit to Taylor, but that no proofs have been subsequently given. I shall have occasion to return to this controversy. The application, however, of steam to Navigation, as well in other countries as in England, down to this period of its introduction, deserves, previously, a brief notice.

CHAPTER III.

RISE AND PROGRESS OF STEAM NAVIGATION.—BLASCO DE GARAY, IN 1543.—MARQUESS OF WORCESTER'S IDEA ENIGMATICAL.—PAPIN SUGGESTS IT IN 1690.—THE FIRST PRACTICAL STEAM BOAT DESCRIBED BY JONATHAN HULLS, IN 1737.—HIS OPINION, A CENTURY AGO, OF WHAT "THE SCHEME" WOULD BECOME "IF ENCOURAGED."—NEVER TRIED.—THE LATE MR. JOHN RENNIE'S OPINION OF CLAIMANTS.—MARQUESS DE JOUFFROY, 1781.—SUGGESTED AND TRIED IN FRANCE, NEXT TO BLASCO DE GARAY, IN SPAIN.—MR. SYMINGTON THE REAL INVENTOR OF STEAM NAVIGATION, AS MR. WATT OF THE STEAM ENGINE.—OBJECT OF THE QUESTION, WHO INVENTED THEM?—MR. SYMINGTON'S, THE FIRST BOAT PROPELLED BY STEAM ON BRITISH WATERS, IN 1788.—LORD STANHOPE'S, IN 1795, THE NEXT.—MR. SYMINGTON'S SUCCESS, IN 1803, COMPLETE WITH THE "CHARLOTTE DUNDAS," THE FIRST STEAM BOAT NAMED IN ENGLAND.—BELL'S "COMET," 1811.

THE first vessel moved by steam was by Blasco de Garay, in the port of Barcelona, in Spain, in 1543, as before stated in the remarks on the Steam Engine. The manner in which the steam was applied to give motion to the paddles is not described.

The first description of what may seem to some to apply to the Steam Engine for Navigation, is in the Marquess of Worcester's "Century of Inventions," published in 1663. He refers to his invention no otherwise, than as "a way how to make a boat work itself against wind and tide; yea, both without the help of man or beast." This, probably, was some impracticable scheme, assuredly never realized, nor likely to be.

The next idea, and certainly somewhat more to be understood, is Papin's, in 1690. He goes so far as to describe the

manner in which motion may be given to the paddle-wheels, by the pistons of the cylinders being notched, and fitting into corresponding notches or teeth-wheels on the axle. It is only necessary, however, to refer to Papin's method of using the piston, and performing condensation, described at pages 71 and 76, to be satisfied that it was impracticable at this period.

The next claimant, however, is fairly entitled to the honour of being the first who gave a reasonable account of Steam Navigation, though it does not appear that he endeavoured to realize the results of his ingenuity: this was Jonathan Hulls, whose idea of it was so far matured, that he protected it by patent in the reign of George II., in 1737.

The plate representing his engine turning the paddle-wheels, placed at the stern of the vessel, and the description of its mode of action, render it dishonest to class him as a mere visionary speculator. His invention was far before his time, and more complete than that of any single inventor after it, inasmuch as his idea embraced the whole, and was perfectly original; whereas, the attempts of all subsequent inventors were combinations of the ideas of others with their own: and, though working with the rude materials of the steam engine of his own day, there seems no reason to doubt that his means would have been equal to a limited application. The plate represents a tug-boat towing a vessel—the same purpose, at first, to which the steam boat was subsequently applied.

In speaking of the different claimants to the invention of Steam Navigation, the late Mr. John Rennie is reported to have awarded the honour to Jonathan Hulls, in these words: "Don't talk of Fulton, or Miller of Dalswinton, or Lord Stanhope, as the inventors of the steam vessel: Jonathan Hulls, and he only, was the inventor. Look at the print in his little book, published in 1737, entitled 'Description and Draught of a new-invented Machine, for carrying Vessels, or

Ships, out of, or into, any Harbour, Port, or River, against Wind and Tide, or in a Calm,' and in it recognize at once the STEAM BOAT, by its paddle-wheels, its smoking chimney, and the tow-rope from her stern to the two-decker she is dragging."

A century has now passed since this original thought was patented by its author, and the great change that has now taken place in the navigation of the globe, even he could not have dreamt his solitary idea could, under any circumstances, have led to. He speaks so modestly of his invention, and so simply—not like the Marquess of Worcester, who describes himself in some such way, as the never-to-be-sufficiently-admired—that it may not be uninteresting to record the opinion of this writer upon the steam boat a hundred years ago—of the then infant power, which, he says, "I now offer to the world, and I hope, that through the blessing of God, it may prove serviceable to my country:" concluding, in prophetic words, "the scheme I now offer is practicable, and, if encouraged, will be useful." He observes, "Whereas several persons concerned in the navigation, have desired some account of my invention for carrying ships out of, and into harbours, ports, and rivers, when they have not a fair wind: but I could not fully describe this machine without writing a small treatise of the same, in which I shall endeavour to demonstrate the possibility and probability of the matter undertaken. There is one great hardship lies too commonly upon those who propose to advance some new, though useful scheme, for the public benefit. The world, abounding more in rash censure than in a candid and unprejudiced estimation of things, if a person does not answer their expectations in every point, instead of friendly treatment for his good intentions, he too often meets with ridicule and contempt; but I hope that this will not be my case, but that they will form a judgment of my present undertaking only from trial. If it should be said that I have filled this tract

with things that are foreign to the matter proposed, I answer, there is nothing in it but what is necessary to be understood, by those who desire to know the nature of that machine that I now offer to the world."

Here is an instance—not a solitary one—of the same prejudice which exists in these days against a new invention, existing a hundred years ago. "The world, abounding more in rash censure, than in a candid and unprejudiced estimation of things," still repays the poor inventor of the present time, with the same neglect as was shown to this offer of Steam Navigation. In nearly every age, a more vigorous intellect sends far into the future the rudiments of some great discovery—a moral or physical revolution; and, conscious of the power of his thought, trusts to posterity for his honours. But ridicule and prejudice meet him in his own day; the two formidable antagonists of reason—oftener masters than the slaves. Success of the new is too frequently estimated more by present knowledge than by analogy of the past; and we find generations slowly toiling to reach what was clearly defined, and ready for their grasp, long years before. To apply the words of Jonathan Hulls, the scheme he offered a hundred years ago was practicable, but, though useful, was not encouraged.

The Marquess de Jouffroy tried a steam boat, 140 feet long, at Lyons, on the river Soane, in 1781; so that France may claim—though she has not—the honour that a Frenchman first thought of, and that a Frenchman first applied, steam to navigation—Blasco de Garay alone excepted. But steam navigation in France, like the solitary attempt in Spain, led to nothing.

It seems contrary to the spirit and meaning of the object of the question—Who invented the Steam Engine and Steam Navigation? to give any other reply than what shall contain an explicit answer; otherwise you must trace all their "scant-

lings," for centuries. This answer can only be the names of those who brought the one into general use, and proved the practicability of the other—Mr. Watt and Mr. Symington.

It was, unquestionably, Mr. Symington who fully realized its practicability, and, by the eminent success that attended his trials at that early period, directed the attention of others towards his efforts; and in speaking of which, the writer of "Steam Navigation," in the Supplement to the "Encyclopædia Britannica," observes, "All the subsequent improvements, however, in Steam Navigation may be fairly traced to Mr. Symington's attempt."

Mr. Symington's first steam boat—and it was certainly the first propelled by steam on British waters—was in the autumn of 1788, on the lake near Dalswinton House, the seat of his patron, Mr. Miller. It answered exceedingly well. The engine was similar to the one for which he had previously obtained a patent.

His second trial was on a larger scale, on the Forth and Clyde inland Navigation, in October, 1789, "in the presence of hundreds of spectators, who lined the banks of the canal to witness what seemed so extraordinary an attempt."

These were his earliest attempts; but their continuance not being then encouraged, his talents were not again so directed, until, under the patronage of Thomas Lord Dundas, he commenced experiments in January, 1801, and shortly afterwards finished a steam boat which completely established the practicability of Steam Navigation. Lord Stanhope, however, subsequently made some experiments in Greenland Dock, in 1795.

Mr. Symington tried his steam boat in March, 1803, on the Forth and Clyde canal. She was named the "Charlotte Dundas," and towed the "Active" and "Euphemia," of seventy tons each, well laden, 19 miles, to Port Dundas, Glasgow, against a strong head wind, amounting to a gale.

After this satisfactory trial, the steam engine was allowed to remain unapplied to navigation. Unable to procure patrons to nurse the rising antagonist of wind and tide, Mr. Symington's resources were too much diminished to enable him to continue subsequent experiments.

The next steam boat built in this country was the "Comet," in 1811, by Henry Bell, who, it clearly appears, took his drawings of the machinery from Mr. Symington's engine.

The next in succession was the "Elizabeth," of 40 tons and 9-horse power, built by Thomson: after which, the subsequent tables will show the progress of Steam Navigation down to the present time.

It is proper to notice here the kind of engine used in navigation, and the difference between it and the locomotive engine. There are but two descriptions of steam engine, the high and low-pressure. All those used in steamers in this country, are low-pressure or condensing engines, as they are termed. In America it is the reverse; for there, chiefly high-pressure engines are used. All locomotive engines are necessarily high-pressure, because they have no condenser, and could not carry sufficient water to supply it to produce a vacuum. The quantity required is very great. Four gallons of cold water a minute for every horse power is the allowance of Mr. Watt; so that 200 gallons of cold water every minute would be necessary to produce a vacuum in an engine of only 50-horse power. In high-pressure engines, steam of a pressure of 40 lbs. or more on the square inch is used, because 15 lbs. the square inch, is only sufficient to neutralize atmospheric resistance to the issue of the steam from the cylinder each time the piston reverses its motion. But in low-pressure engines, a vacuum being produced on the opposite side of the piston to which the steam is pressing, by condensing the previous steam immediately it has performed its duty, there is no resistance to the motion of the piston to conquer; con-

sequently, it is unnecessary to use steam of a higher pressure than will overcome the friction of the piston and other moving parts. This ranges from 4 to 16 lbs. in different steamers. In Cornwall, however, where more duty is performed by the same quantity of fuel than elsewhere, 30 to 40 lbs. pressure per square inch is generally employed, though all those engines are condensing engines. A high-pressure engine on board a steamer would probably ruin the proprietor, by the fears and prejudices of the public, though on railways, where none other are used, people travel by them without apprehension or danger.

The following is the manner in which a condensing engine is set to work:—Steam is admitted into the cylinder, and circulates through every part of the engine, being condensed, or reduced partly to water, by clinging to the cold surfaces it meets, until they are nearly of the temperature of 212°: it then continues rushing through every portion of the machinery, without being condensed, driving the air before it, and seeking to escape, which it does through a valve opening upwards, called the snifting-valve. The rattling noise it makes with the flap of this valve, as the air is expelled, warns the engineer that the parts are sufficiently warmed and free of air to be in working order. He then turns on the injection jet of cold water into the condenser; the steam is annihilated in a moment, and a vacuum thereby produced: the piston immediately feels relief from the resistance on the opposite side to which the steam is pressing, and slowly begins to move. The steam is again condensed immediately it has forced the piston to either end of the cylinder; the vacuum being more perfect, the steam now exerts its full power, and the ponderous beam, instinct with life, moves rapidly, obedient to nature's laws. It is unnecessary, perhaps, to observe, that it is the surprising expansive or elastic properties of steam, that alone endow it with its stupendous

power, and gives it the energies it uses for our service. A cubic foot of water converted into steam will fill a vessel whose capacity is 1728 feet, or nearly two thousand times its former bulk. We shall not wonder, then, that a body so exceedingly elastic, confined in a large strong tube like the cylinder, should seek to expand itself, and, by pressing equally in every direction, and finding the piston the only part yielding to its pressure, exert on that all its power. This power being suddenly withdrawn on one side by its reduction, through condensation, into its former powerless state, whilst it is, at the same time, applied on the opposite side of the piston, explains at once the principle of the steam engine.

CHAPTER IV.

RIVAL CLAIMS TO THE INVENTION OF STEAM NAVIGATION SET AT REST BY DATES.—MILLER, TAYLOR, FULTON, BELL.—SYMINGTON'S LETTER TO TAYLOR EXPLAINED.—HIS CLAIM UPON NATIONAL GRATITUDE CONSIDERED.—THE PRINCIPLE WHICH SHOULD GOVERN SUCH REWARDS.

HAVING already shortly adverted to the article on Taylor in "Chambers' Journal," a few further observations are necessary to dispose—I hope I may say for ever—of the pretensions of Miller, Taylor, Fulton, and Bell, who have contended, or their injudicious partisans for them, for the honour of the invention of Steam Navigation.

Miller, in the pamphlet of his experiments in propelling boats by mechanical means, published in 1787, says:—"I have also reason to believe that the power of the steam engine may be applied to work the wheels." This idea he certainly had from Symington, in a conversation on the occasion of the latter exhibiting his model of a Steam Carriage, in 1786; for Symington was also the first to originate, and the first to prove, by a working model, the application of steam to locomotion. He then pointed out to Miller, how much more continuous and effectual his boat might be propelled by steam, than by horses, manual labour, or other mechanical substitution for wind.

This conversation led to Symington's employment by Miller to prove its practicability. Whoever, therefore, first thought of the scheme, all, at least admit, that Symington was employed to construct and arrange the machinery, to

superintend the application of the engine, and to produce a rotary motion; in fact, to make the steamer effective. This must be considered important evidence in determining, at this distance of time, the rights of contending claimants. It affords the best proof that Symington was, at least, the practical engineer; and that the other claimants, at this period, were wholly incapable of applying the invention. Symington, there can be no reasonable doubt, was the genius, Miller the patron. Had he not, at that time, acquired the fame of being the originator, it is not probable that Lord Dundas would, fifteen years afterwards, have selected him, as before stated, to renew the experiments.

Taylor had been the schoolfellow of Symington, and was then tutor in Miller's family. So circumstanced, it was not difficult for Miller and Taylor to appropriate to themselves, and contend for an honour due to neither of them; whilst the real author, like too many others, was obliged to leave to the slow but irresistible power of time, to return to him the credit of a valuable invention.

The chief evidence upon which the editors of "Chambers' Edinburgh Journal" were content to claim it for Taylor, is the following extract from a letter from Symington to him, dated in 1787:—

"I must make some remarks on your summer's invention, which, if made to perform what its author gives it out for, will undoubtedly be one of the greatest wonders hitherto presented to the world, besides being of considerable emolument to the projector. Great success to you, although overturning my schemes; but take care we do not come upon your back, and run away with them by some improvement. Your brother John gives a kind of credit to your report, which, for some reasons, I did not discourage.

"I must conclude," &c. &c.

(Signed) "Wm. Symington."

Admitting, as they do, that "Mr. Taylor was requested to find out a proper engineer for the purpose, and William Symington, who had invented a new construction of the steam engine, (by throwing off the air-pump,) being at that time in Edinburgh for his education, he recommended and introduced him to Mr. Miller," they have not exercised that caution and patient investigation of evidence, due to the real author and the public, in awarding an important invention to a person who, by their own account, was incompetent to apply it. The talent of the then youthful inventor of Steam Navigation is sufficiently shown by this extract; for even whilst pursuing his education, Symington "had invented a new construction of the steam engine."

Mr. Symington, at the period referred to in his letter, had his thoughts occupied with Steam Navigation, and this is the scheme he refers to, that Taylor's invention would overturn, if successful. That invention was nothing more than a pump, by which water was to be powerfully forced in one direction, that the boat might be propelled in another by the reaction. Sometime ago I witnessed, with Mr. Brunel, a similar absurdity, revived on a large scale. The sanguine inventor had covered sheets with abstruse calculations, to show what "pull" it would have, proving to demonstration, on paper, that it *could not* fail—but it did. He had, unfortunately for himself, dealt somewhat too largely in hypotheses, and would hear of nothing but what squared with them. Thus, when the pump had a barge in tow, which, looming somewhat above the water, presented a fair extent for the wind, and the wind blew adverse, the barge went backwards, "pulling" the pump, instead of the pump "pulling" the barge.

As regards the claims of Bell and Fulton, it is difficult to conceive by what deduction or calculation, unless by inverse ratio, can be awarded to either, any further merit than having perseveringly availed themselves of Symington's talent.

Dates give accuracy to events, and decide, without appeal, the priority of claimants. Symington's steam boats were in 1788, 1789, and 1803: Bell's in 1811.

Fulton availed himself of Symington's liberal permission, in July, 1801, to take drawings of his steam boat and machinery, and was kindly taken, by Symington, a short trip on board, who had the fires lighted and the steam got up solely for that purpose. This was a fine instance of generosity at that period of the then infant invention. Fulton, however, was some time before he applied this knowledge. His "humane and philanthropic mind" was employed in "the useful and honourable amusement" of devising means quietly to blow up whole ships' companies like lightning. He offered his submarine torpedos to Buonaparte, to destroy the British fleet "at a blow." Buonaparte was in ecstasies with such wholesale murderous prospects; but after an inquiry Buonaparte called him a schemer, and would have nothing to do with him. The Dutch rejected him. He then crossed the Atlantic, with his torpedos in one pocket and Symington's invention in the other; but finding these infernal machines were likely to go to sleep, he started the first steam boat on the Hudson, in 1807, and, with amiable modesty, claimed the invention as his own. Even the engines, however, were made by Boulton and Watt.*

* Mr. Cadwallader Colden's "Life of Fulton" is amusing. A most entertaining gentleman, with a sly but very grave humour, is Mr. Cadwallader Colden. After invoking all bards, past, present, and to come, to sing pæans to Mr. Fulton's praise, as the *inventor* of Steam Navigation, "whose name," says Mr. Cadwallader Colden, "dear to fame, shall be engraven on a monument sacred to the benefactors of mankind," Mr. Cadwallader Colden shows what mighty things his "humane and philanthropic friend" could, would, or should have done, in destroying the whole British fleet at a blow, with his "useful and honourable amusements"—if he could have got at it. Mr. Cadwallader Colden makes us

The grand improvements on the steam engine by Mr. Watt, have since led to results so far beyond conception, as completely to overshadow any application of his inventions by others, and thus only his name is left associated with them all. He did so much that it became more difficult, and reflected more credit on his cotemporaries, to do anything in a field of discovery which he had explored and exhausted; still it was a bold, and, with Mr. Symington, a perfectly original idea, the application of this power to overcome the elements.

It is singular that Mr. Watt does not seem to have thought it practicable, otherwise one at least of his many admirers would not have failed to award him this honour; an honour, however, that he alone can afford to be deprived of. It is sufficiently important to be rescued from the uncertainties that time throws over the origin of all things, and to be awarded to him to whom the honour is due. Now it seems unquestionable that it was no other than the neglected Symington, who first gave that impulse to Steam Navigation which others continued only from the momentum it had received from his successful efforts, but which none of them had original talent sufficient to set in motion. A little host of gleaners have, however, sprung up to quarrel for the honour of the invention, and they buzz about, and make more noise with their idle claims, than if they themselves had sown and reaped.

The excellent steam engines patented by Mr. Symington, and erected in England and Scotland, without infringing upon Mr. Watt's improvements, his other ingenious inventions,

feel more grateful to our guardian genius, Britannia, that Fulton never had the opportunity; for, says Mr. Cadwallader Colden, in his sly way—"In *one* instance he (Fulton) came near a British 74, but she changed her position just in time to save herself from being blown into the air." "First catch your hare," says Mrs. Glasse.

and his successful efforts in Steam Navigation, form the best evidence that he possessed a far higher order of talent than that of the mere mechanic, sufficient only to apply the inventions of others—not to originate.

As regards Mr. Rennie's opinion that Jonathan Hulls was the inventor, and admitting, for the moment, what is very improbable, that Symington, living in the bleak scenery of the Wanlock-head Lead Mines, Dumfriesshire, had heard of Hulls' idea, or even that Taylor, or Miller, first *thought* of applying steam to navigation, we attach no value to mere immature ideas, stifled at their birth; they are but the still-born fancies of sickly parents that have not vigour to bring them to maturity. It is more than probable that, looking to what Symington really did do for Steam Navigation, the same mind that originated and produced the first working model of applying steam to move carriages, would, by the same reasoning, suggest, Why not to move boats also?

But be that as it may, we do not consider him the inventor who predicts, or even partially executes, but he who completes and perfects. Which of the two confers the benefit upon his kind? We raise not monuments to perpetuate the names of Hero, Papin, Savery, or Newcomen: we record them, to do justice to their several improvements on the steam engine; but we turn with reverence, and erect statues, to him who, seizing the uncouth mass, and melting it down in the crucible of his mind, cast the material in the mould of his own original genius, and turned out a perfect invention.

Neither can we consider him the inventor of Steam Navigation, who did no more for it than to think about it. We might, with the same reason, give the merit to Darwin, who, in the last century, wrote that the time may come when the barges on our canals, and the coaches on our roads, would be moved by the power of steam. But it is a mere play upon words to call these ideal writers, or thinkers, the inventors.

We naturally seek to distinguish him as the inventor, who had the boldness to set about it, and the talent first to prove its practicability. Seneca foretold another world; Columbus discovered, and gave it to our grasp. Whose was the gift? Who the benefactor? So was it with Hulls, and Taylor, and Symington. Let us, then, act justly, and give our gratitude to him who patiently meets the ridicule of his cotemporaries by continuing his labours, and, undeterred by the risk of failure, meets difficulties only to overcome them; who, supported throughout by a clearness of perception that he would ultimately embody his combinations, devotes, year after year, his time, his property, and his health, applying means to ends, and at last triumphantly establishes, by his success, the brilliant anticipations of his genius. He alone deserves the honour of an invention, who makes it generally useful to mankind. Hulls was before his time, but only in thought. Symington was also, both in thought and application; for it was not until 1817 that the public began to awaken to the great value of the power, which Symington had, years before, shown them how to apply and control. Clearly, Mr. Symington was as much the inventor of Steam Navigation, as was Mr. Watt of the Steam Engine. Before Mr. Watt's time the steam engine was comparatively useless: before Mr. Symington's time a steam vessel was unknown, or known only to be ridiculed.

When, therefore, we behold the rivers of a great empire, and the ocean that surrounds our shores, covered with steam boats dispensing so prodigally the cheap and accessible means of health and enjoyment to the over-worked population of a crowded metropolis; vast fabrics conveying, unmoved by wind or tide, perishable commodities to every part of the kingdom with certainty and celerity that could form no part of the imagination of the wildest schemer of the past generation; time and distance reduced; fruits and vegetables of

distant nations brought fresh to our tables; and that world which, not so far back, was only discovered after months of difficulty and peril, brought to us within the safe and certain distance of a few days; we cannot withhold our sympathy from the able but neglected individual, who devoted the best of his life in proving the practicability of a scheme which now forms part of the prosperity of the nation, and is felt a source of convenience and enjoyment by every individual.

It is a melancholy reflection, that Mr. Symington, having expended his property in the pursuit, should have wanted just that little more that would have enabled him to realize the reward due to his talent and industry. We cannot, indeed, readily conceive the keenness and bitterness of his disappointment when, deprived of the means of continuing his invention, by their expenditure in the accomplishment of his object, he saw, without the power of prevention, others reap what he had sown, and thus left to his family only the honour of the discovery. Had Mr. Symington met with a patron or partner so liberal and wealthy as Mr. Watt found in Mr. Boulton, he would have enjoyed, and bequeathed to his family in the wealth that would have flowed in upon him through his patents, a fortune equal to the importance and value of his invention.

Individuals display, on too many occasions, an ungenerous propensity to lessen merit, and to relieve themselves of obligations by depreciating their benefactor. The application of steam to navigation is now considered to have been a matter of easy attainment, simply because familiarity, which success has produced, leads us to forget in its perfection the struggles of its origin. The labour of its birth is forgotten in its manhood. We cannot bring our minds to contemplate a period we never knew. We are unequal to the task of throwing back our ideas to that time when an invention was slowly struggling into being, surrounded by an accumulation of ob-

stacles, that none but a vigorous mind and persevering efforts could have brought to light and maturity. But it is not so ordered that anything worth having is to be attained without unwearied application. Those who have most benefitted or delighted mankind by their genius, have laboured the hardest. We take, then, but a narrow and ungenerous view of things, if we estimate only by its accomplishment, the difficulties surmounted in a great undertaking; or forget, in the enjoyment of its benefits, our gratitude to its author. When we read the immortal page, or gaze upon some perfection of art, feeling that we take in a portion of that inspiration which glowed within the master-spirit in its progress, and which so magically speaks to us from his work;—the magic touch, indeed, that at once identifies the reader with the author, or makes the glowing canvass and animated marble start into life to our senses, which unless we feel to some degree we see but the mere canvass and the stone, or at most the laboured workmanship of the dull mechanic: when thus interested in such creations of the mind, we are too apt to imagine these wonderful works of man have sprung, like Pallas from the brow of Jove, heaven-born from genius. We think not, because we know not, the silent struggles with difficulty and distress all but insurmountable; we heed not the mental toil, and wearing alternation of excitement and depression in its attainment: satisfied with the production, we care not to inquire the means. Yet, if we draw aside the curtain to know how the mighty work was achieved, we see, by the rubbish that has been struck off, and in the accumulations of the studio, the magnitude of the obstacles overcome, as the work slowly rises to perfection.

There are few, it is hoped, but who feel, and feel forcibly, that it is an equitable practice, founded on the best principles of justice, for a government to reward the family of an individual, whose means of support at his death have been re-

duced, in giving to a nation a valuable invention. His claim is equal to the soldier or the sailor. He who has devoted time and intellect in benefitting his country, and has himself reaped no reward for his services, but injured his family in bringing it to maturity, deserves, from the abundant produce of its application, at least a small portion of the interest which every one enjoys. Lord Liverpool, when Prime Minister, acknowledged its importance to government, when he said, "I have lived in times when the success of a campaign, or even of a war, has depended upon the possibility of despatching our squadrons from port, and when contrary winds prevailed for whole months, and completely disappointed the anxious wishes of government. Thanks to the steam engine, such vexatious difficulties are now for ever at an end."

It is an ungenerous occupation to seek relief from the obligation of reward to the talented inventor, in the excuse that some one else would have made the discovery. Still, that other would but have occupied his position, and have been entitled to the benefit. In defending Mr. Watt's claims to his inventions, it was observed, in answer to the infringers of his patents, deprecating rewarding ideas, "Away, gentlemen! fret as you list against these untangible combinations, as you call Mr. Watt's machines, but know that these abstract ideas could crush you like so many gnats, and shoot you out of sight into the air." Mr. Watt had the means, through Mr. Boulton, of defeating these piratical gentlemen, and so secured a splendid fortune through his patents. Symington had no such opportunity when his patents for Steam Navigation were infringed; poor and friendless, he yielded, with almost a broken spirit, to a destiny he could neither foresee would have been the reward of his labours, nor conquer when it overtook him.

The principle of rewarding authors of inventions that have

benefitted the country, has been frequently admitted in bestowing compensation. Compton was granted £5,000 for his mule-jenny; Cartwright £10,000 for the power-loom; Harrison £20,000 for his chronometer; and Palmer a considerable sum for his system of mail-coach travelling; besides others. After these instances, it would be difficult to discover upon what ground Symington's family have no claim upon the nation, for facilitating intercourse by water against the formidable barriers of wind and tide, particularly after Palmer was rewarded for the far less important improvement of inland travelling.

AUTHORITIES

IN FAVOUR OF

SYMINGTON'S CLAIM TO THE INVENTION

OF

STEAM NAVIGATION.

THE FOLLOWING EVIDENCE IS SELECTED FROM AUTHORITIES IN FAVOUR OF SYMINGTON'S CLAIM TO THE INVENTION OF STEAM NAVIGATION.

*** For correct dates, see page 125.

"In 1795, Lord Stanhope made an experiment in Greenland Dock.

"From this period (1794) till 1801, but little progress appears to have been made in this species of navigation. In that year Mr. Symington, who had been employed in the construction of Miller's vessel, tried a boat, propelled by steam, on the Forth and Clyde Inland Navigation."—*London Encyclopædia*, Article, "Steam Engine."

"Mr. Symington took out a patent for steam boats, in the same year, (1801;) and he has the undoubted merit of being the first person who applied the power of the steam engine to produce motion in vessels."—*Captain Basil Hall's Travels in North America*, vol. ii. page 387.

"Mr. Miller, of Dalswinton, having seen a model of a steam carriage, invented by Mr. W. Symington, of Falkirk, was so much pleased with it, that he directed the inventor to make a small steam engine to work a twin or double boat. An experiment was made in 1788, and answered so well that he had another boat made on a larger scale; which he tried on the Clyde and Forth canal, in 1789. The method employed by Mr. Symington for making the connexion between the paddle-wheel and piston, was by placing the cylinder in a horizontal position."—*Encyclopædia Metropolitana*, Article, "Manufactures," page 218.

"It is remarkable, also, that the unfortunate Symington, who has such claims to the original invention of the steam boat, had previously contrived a similar application for the propelling of carriages; and actually exhibited, in the year 1787, [and in 1786,] in the house of Mr. Gilbert Meason, in Edinburgh, the first model of a steam carriage that was, perhaps, ever seen."—*Quarterly Review*, March, 1830, Article on "Locomotive Carriages," page 380.

"In Italy, the application of steam power to vessels was proposed by Dr. S. Serratti; and in Scotland, by Mr. Miller,* of Dalswinton, who, afterwards, on the sight of a model of a steam carriage, invented by Mr. William Symington, of Falkirk, was so much pleased with the mode, that he desired Mr. Symington to make him a small steam engine to work a twin or double boat on Dalswinton Loch. The engine having been accordingly executed and put on board the boat, the experiment was made at Dalswinton, in the autumn of 1788, and it succeeded so well, that Mr. Miller commissioned Mr. Symington to purchase a gabert, or large boat, at Carron, and to fit up a steam engine on board of it, to make a trial on a large scale. Everything being completed, the trial was made on the Forth and Clyde canal, in the summer of 1789, Messrs. Miller, Stainton, Taylor, and others, being on board, and the result answered their most sanguine expectations; but, most unaccountably, after having thus established, at a considerable expense, the practicability of employing the power of steam in navigation, Mr. Miller seems to have neglected it entirely. In 1801, Mr. Symington was encou-

* The mistake which some of these writers have fallen into, in speaking of Miller as the person who first *thought* of applying steam to navigation, arose, no doubt, from the publication of his book, referred to at page 99. The probability is as nothing, that he, and not Symington, was the real author of the idea, when the fact there stated, and the inference at page 104 are dwelt upon.

raged to proceed with a steam boat, by Thomas Lord Dundas, of Kerse, who wished that one might be applied to drag vessels on the Forth and Clyde canal, instead of horses; and accordingly, a series of experiments on a large scale, which cost nearly £3,000, were set on foot in the year 1801, and ending in 1802. The boat Mr. Symington made was for towing, and it had a steam cylinder 22 inches in diameter, and four feet stroke. A complete model of it, with a set of ice-breakers attached, may be seen at the rooms of the Royal Institution, in London. This tow-boat proved to be very much adapted for the intended purpose."—*Oxford Encyclopædia*, 1828, Article, "Steam Navigation."

"The earliest successful application of steam, appears to have been made on the Forth and Clyde Inland Navigation, by Mr. Symington."—*Elijah Galloway on the Steam Engine.*

"In the year 1801, Mr. Symington tried a vessel propelled by steam on the Forth and Clyde Inland Navigation. The method (of moving the paddle by a horizontal cylinder) is attended with several advantages; the necessity for a beam is avoided, which has ever been a troublesome and expensive part of the common engine."—*Burrowe's Modern Encyclopædia*, Article, "Steam Engine."

"This was the first public trial (1802) of steam for a useful purpose in Navigation."—*Report of the Proceedings of the Managers of the Forth and Clyde Canal Company, with respect to Steam Navigation.—Mechanics' Magazine, July* 9, 1831.

"England, however, claims the honour of first applying steam to the purposes of navigation. In 1736, Mr. Jonathan Hulls took out a patent for a boat to be propelled by the aid of steam . . . but it was, however, never carried into practical execution by Hulls, probably from the want of funds and sufficient encouragement. It is not our province, in this article, to trace the many other attempts that were made to carry on and perfect this great invention; but we

may remark, that in 1802, Mr. Symington actually constructed a steam boat on the Forth and Clyde canal, and that it was only abandoned, in consequence of some narrow-minded proprietors of the Navigation conceiving that the undulation of the water, occasioned by the motion of the wheel, would wash and injure the banks; and in consequence the boat was, with great reluctance, laid up in a creek of the canal, near Bainford Drawbridge, exposed for years to public view. It is a remarkable fact, however, in the history of this great invention, that Mr. Fulton, for whom the Americans have, with some unfairness, claimed the original invention of the steam boat, actually visited Mr. Symington in 1802; and, having mentioned the interest he felt in this new application of steam, Mr. Symington caused the engine fire to be lighted up, and carried Mr. Fulton in the steam boat, from Lock No. 16, where the boat lay, four miles west the canal, and returned to the place of starting in one hour and twenty minutes, to the astonishment of Mr. Fulton, and several other gentlemen, who happened at the outset to come on board.

"This simple and incontrovertible fact decides, in the most unquestionable manner, that the invention of the steam boat is due, both in theory and practice, to Great Britain."—*Brewster's Edinburgh Encyclopædia*, Article, "Ship Building," pages 215, 216.

"But Mr. Symington was the first person who had the merit of successfully applying the power of the steam engine to the propulsion of vessels."—*Encyclopædia Londinensis*, Article, "Steam Engine."

"It is indisputable, therefore, that Mr. Symington was the first person who had the merit of successfully applying the power of the steam engine to the propulsion of vessels. The boat which he constructed was, like that proposed by Hulls, really a tug.

"It is much to be regretted that there existed not enterprise enough at that time, in Scotland, to encourage the ingenious artisan to repeat his experiments on the Clyde. All the subsequent improvements, however, in steam navigation, may be fairly traced to Mr. Symington's attempt; and we cannot help thinking that he has a strong claim on the national gratitude. He is still alive, and, we fear, not in the most flourishing circumstances. Should the state decline rewarding such meritorious services, the opulent proprietors of steam boats might well evince their liberality and discernment, by bestowing on him some recompense."—*Supplement to the Encyclopædia Britannica,* Article, "Steam Navigation."

Mr. Symington is since dead. He petitioned in vain for an inquiry into his claims, having procured, at considerable expense, affidavits and drawings of his original steam boats in support. Put off, from time to time, with the hope deferred that maketh the heart sick, and which soon breaks it, when the spring of early life is destroyed by misfortune, or too much weakened to give back the pressure, all he received from Government was £150. He lived, however, to see his invention carried out, to an extent beyond even his own sanguine expectations, in the vast results to his country and the world, that arose out of his successful efforts. But this gratification, which, under more prosperous circumstances, would have afforded the highest and purest enjoyment, carried with it, in his poverty, the bitterest alloy, and contained the seeds of his premature death. He saw what great things his labours had led to; the large profits derived from the piracy of his patents; he found even his petition for investigation refused. He could thus only look upon what he was not destined to enjoy, and suffer the agony of knowing that he was powerless of means to prevent it—the one alone, who derived no benefit from his exertions. When

to these is added, what, perhaps, is still more painful to the man of conscious talent, the award to another of the honour of his invention, he felt such recompense for the large boon he had given to the world, with all the acute sensitiveness that gathers poignancy from every slight, and accumulates, just when it should not, to strike the victim, and become the curse of neglected talent. All these forcibly operated upon Mr. Symington's mind, at a time when a feeble state of body was ill calculated to bear it, and he sunk under the unmerited infliction. Nothing is more calculated to excite the compassion of a benevolent heart, than these fruitless struggles of talent unrecompensed. Thus died, on the 22nd of March, 1831, he whose genius first taught mankind to conquer the elements, leaving his family to claim the justice denied him whilst living—that byeword among nations, "*a country's gratitude!*" *Fiat justitia.*

It is seldom that poetry finds the rugged path of science sufficiently attractive to lend its divine aid to celebrate the discoveries of the philosopher, and that the name of the poet is preserved merely by the connexion. It frequently happens, however, that what is not worth notice in itself, is saved from oblivion by association with matters that must always interest mankind. The name of Symington thus returns tenfold to Mr. Muir, of Kirkintilloch, for his poem,

"*On Seeing, in March,* 1803, *the new Steam Boat, or Nautical Novelty, invented by William Symington, pass through the Great Canal, dragging two vessels fully loaded.*"

When first, by labour, Forth and Clyde
Were taught o'er Scotia's hills to ride
In a canal, deep, lang, and wide,
Naebody thought
Sic wonders, without win' or tide,
Wad e'er be wrought.

To gar them trow that boats wad sail,
Thro' fields o' corn, or beds o' kail,
An turn o'er glens their rudder tail,
Like weathercocks,
Was doctrin' that wad needed bail
Wi' common folks.

They ca'd it nonsense—till at last
They saw boats travel east an' wast,
Wi' sails an' streamers at their mast;
Syne, without jeerin',
They were convinced the blust'rin blast
Was worth the hearin.

For mony a year, wi' little clatter,
An' naething said about the matter,
The horses harl'd them thro' the water,
Frae Forth to Clyde;
Or, the reverse, wi' weary splatter
An' sweaty hide.

Then we believ'd, puir silly bodies,
Wha naething ken o' learned studies,
That horses' hoofs and hempen woodies
Boot still to draw them;
An' cursin' callants clad in duddies,
To swear and ca' them.

But little think we what's in noddles
Whare science sits, an' grapes and guddles,
Syne darklins furth frae drumly puddles
Brings things to view,
That the weak penetration fuddles,
O' me an' you.

For lately we hae seen a lighter,
An' in her doup a fanner's flighter,
May bid boat-haulers a' gae dight her
Black sooty vent;
Than half a dizzen horse she's wighter,
By ten per cent.

Wi' something that the learn'd ca' steam,
That drives at heughs the waukin beam
O' huge engines to drain coal seam,
Or carry hutches;
She in her breast swalls sic a feam,
As has few matches.

By it she thro' the water plashes,
An' out the stream ahint her splashes,
At sic a rate, baith frogs an' fishes
Are forc'd to scud
Like ducks and drakes, amang the rashes,
To shun the mud.

When first I saw her in a tether,
Draw twa sloops after ane anither,
Regardless o' the win' an' weather
Athwart her bearin',
I thought frae hell she had come hither,
A privateerin'.

An' that the pair she had in tow
War prizes, struck me sae, I vow,
I cry'd, when fixet to their prow
I saw her cable,
In Satan's furnace now they'll low
Amang the rabble.

It was sae odd to see her pullin',
An' win' an' weather baith unwillin',
Yet deil ma' care, she, onward swellin',
Defied them baith,
As constant as a mill that's fullin'
Gude English claith.

Can e'er, thought I, a flam o' reek,
Or boilin' water's caudron smeek,
Tho' it war keepit for a week,
Perform sic wunners,
As quite surprise amaist the feck
O' gazin' hunners.

But facts we canna weel dispute them,
Altho' we little ken about them;
When prejudice inclines to doubt them,
Wi' a' her might,
Plain demonstration deep can root them,
An' set us right.

Ere lang gae now, wi' whirligigs
An' steam engines we'll plough our riggs,
An' gang about on easy legs,
Wi' nought to pain us,
An' flit in tethers useless naigs,
That used to hain us.

Braw news indeed for man and beast!
They'll then hae nought to do but rest,
An' on their former labours feast,
Wi' cheerfu' heart,
When thus they see warm steam insist
To play their part.

SUMMARY OF THE

RISE AND PROGRESS OF STEAM NAVIGATION,

CHRONOLOGICALLY ARRANGED;

AND

THE PRESENT STATE OF THE STEAM MARINE OF

THE BRITISH EMPIRE,

AND OF

THE UNITED STATES OF AMERICA.

TABLE, No. 1.

TRACING THE RISE AND PROGRESS OF STEAM NAVIGATION IN THE CHIEF CAPITALS OF THE UNITED KINGDOM, AND PLANTATIONS; FROM THE FIRST VESSEL PROPELLED BY STEAM, ON BRITISH WATERS, OF 4 TONS AND 1-HORSE POWER, BUILT BY SYMINGTON, IN 1788, TO THE "BRITISH QUEEN," OF 2016 TONS AND 500-HORSE POWER, BUILT IN 1838, FOR THE BRITISH AND AMERICAN STEAM NAVIGATION COMPANY.

Years.	ENGLAND.		SCOTLAND.		IRELAND.		Total in United Kingdom.		British Plantations.		Total built in the British Empire.	
	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.	Vessels.	Tonnage.
1788	—	—	1	4	—	—	1	4	—	—	1	4
1789	—	—	1	30	—	—	1	30	—	—	1	30
1795	—	—	1	—	—	—	1	—	—	—	1	—
1801	—	—	1	80	—	—	1	80	—	—	1	80
1812	—	—	2	65	—	—	2	65	—	—	2	65
1813	3	108	4	253	—	—	7	361	—	—	7	361
1814	—	—	5	285	—	—	5	285	1	387	6	672
1815	2	161	7	625	—	—	9	786	1	608	10	1394
1816	4	298	4	270	—	—	8	568	1	670	9	1238
1817	4	227	3	194	—	—	7	421	3	1633	9	2054
1818	3	1124	3	216	—	—	6	1340	3	1198	9	2538
1819	2	175	2	167	—	—	4	342	—	—	4	342
1820	3	102	4	403	1	150	8	655	1	116	9	771
1821	12	1463	10	1545	—	—	22	3008	1	258	23	3266
1822	23	2080	4	369	—	—	27	2449	1	185	28	2634
1823	17	2344	2	125	—	—	19	2469	1	52	20	2521
1824	12	1687	5	547	—	—	17	2234	—	—	17	2234
1825	19	2600	5	403	—	—	24	3003	5	1189	29	4192
1826	50	5920	22	2718	—	—	72	8638	4	404	76	9042
1827	18	2264	9	994	1	118	28	3376	2	408	30	3784
1828	25	1687	5	352	—	—	30	2039	1	246	31	2285
1829	13	1080	3	671	—	—	16	1751	—	—	16	1751
1830	10	931	8	814	—	—	18	1745	1	481	19	2226
1831	24	2054	7	695	—	—	31	2749	5	1687	36	4436
1832	19	943	14	1908	—	—	33	2851	5	1239	38	4090
1833	27	1964	6	964	—	—	33	2928	3	1017	36	3945
1834	26	3453	10	1675	—	—	36	5128	3	628	39	5756
1835	63	6844	23	4080	—	—	86	10924	2	357	88	11281
1836	43	5924	20	2834	—	—	63	8758	6	942	69	9700
1837	53	6223	22	4488	3	958	78	11669	4	478	82	12147
1838	66	6286	18	3263	—	—	84	9549	3	288	87	9837
Total at each place.	541	57942	231	31037	5	1226	777	90205	57	14471	834	104676

No Steamers have been built at the Islands of Jersey, Guernsey, and Man. The tonnage is exclusive of the space occupied by the engines.

COMMENTARY ON THE PRECEDING TABLE, WITH REFERENCE TO AMERICA.

1788—9. Both built by Symington, and the first boats propelled by steam on British waters. The second was of 9-horse power.

1795. Lord Stanhope propelled a vessel by steam in Greenland Dock. Power and tonnage unknown.

1798. The American Legislature passed an act, vesting in Mr. Livingstone the exclusive right of navigating all the waters in New York, with steam boats, for twenty years, on condition of his producing a steamer, within a twelvemonth, whose rate should not be less than four miles an hour. Mr. Livingstone, however, was unable to accomplish it, and, in a paper drawn up by him, inserted in the American Medical and Philosophical Register, honestly admits all his experiments had been unsuccessful; in consequence of which, he subsequently joined Fulton in his efforts. The following is a not uncommon instance of that extreme ridicule with which many a valuable invention has been met by those who, confining their knowledge only to one, and that, perhaps, a narrow department, despise what they have not investigated, and will not investigate what they despise. It is, besides, curious at this time of universal extension of Steam Navigation, and shows, that he who first proved its practicability, could have been no ordinary man. Upon Mr. Livingstone's bill being brought before the House of Assembly, Dr. Michell, who introduced it, says, "The wags and the lawyers in the House, were generally opposed to my bill. I had to encounter all their jokes, and the whole of their logic. One main ground of their objection was,

that it *was an idle and whimsical project, unworthy of legislative attention.* . . . It was a standing subject of ridicule throughout the session; and, whenever there was a disposition to indulge in a little levity, they would call up the steam boat bill, to divert themselves, at the expense of the project and its advocates."

1802. Steam Navigation first attracted the notice of a scientific body. It is observed, in the Journal of the Royal Institution of Great Britain, of this date:—"Several attempts have been made to apply the force of steam to the purpose of propelling boats on canals, and there seems to be no reason to think the undertaking by any means liable to *insuperable* difficulties. Mr. Symington appears to have had considerable success, and the method that he has employed for making a communication between the piston and the water wheels is attended with many advantages."

1803. The "Charlotte Dundas," of 20-horse power, the first steamer christened in Great Britain, and the first that took a vessel in tow, built by Symington. The practicability of Steam Navigation in America, first attracted, in this year, the notice of a scientific body in the new world, the American Philosophical Society. In the sixth volume of their Transactions, Part I., p. 96, is a Report read by Mr. B. H. Latrobe, to whom the subject had been referred, which is curious at this day. "A sort of mania," the Report tells us, "began to prevail, which, indeed, has not yet entirely subsided, for impelling boats by steam engines. Dr. Franklin proposed to force forward the boat by the immediate action of the steam upon the water." Even that eminent philosopher was derided. The following was the dictum of these venerable vegetables, who could expand nowhere

but in their own soil; the question having been at the time set at rest by Symington's "Charlotte Dundas." It does not give a very high notion of scientific bodies of that day, the first, generally, to ridicule what had not been proved practicable. "There are, indeed, general objections to the use of the steam engine for impelling boats, from which no particular mode of application *can* be free." I have not, therefore, inserted in their order here, the futile experiments made on the Delaware, by Fitch, in 1783, and by Rumsay, also an American, on the Thames; for the last certainly applied the steam to work a vertical pump, to propel the boat by the reaction of the discharge of the water, and not to move paddles. Had their experiments been worth notice, they would have found a place in such a paper, in the same way that Symington's found in the Journal of the Royal Institution of Great Britain, before extracted. Their plans were unquestionably original, but they lose much of their merit by being impracticable.

1807. The "North River," built by Fulton, the first steamer that ever plied as a passage boat. She was employed on the Hudson, and performed the distance from New York to Albany, 150 miles, in 32 hours. No circumstance can prove more clearly that the world is indebted to Symington's successful efforts in steam navigation, than the fact, that Fulton, who, there is undoubted evidence, witnessed Symington's experiment, and took drawings of his steam boat, introduced the first steamer used anywhere for useful purposes. And before Bell's "Comet," there were also three other steamers running in the United States.

1812. The "Comet," of 25 tons and 4-horse power, built by Bell; and the "Elizabeth," of 40 tons and 9-horse power, built by Thomson; the former plying between Glasgow

and the Helensburg Baths, the latter on the Clyde—the first steamers employed as passage boats in this country.

1813. The editor of the Monthly Magazine, of this date, writes, "We consider this invention as worth to mankind more than a hundred battles gained, or towns taken." The various periodicals of this period abound in notices of the steam boats in America, and regret that they are known in England only by description.

1814. The "Swiftsure," of 387 tons, built in Quebec; the first steam vessel used in British Plantations.

1815. The "Margery," the first steamer that plied on the Thames: between London and Gravesend. The first sea-voyage of an English steamer, (the "Thames,") made from Glasgow to Dublin, thence to London; and the first steam voyage from London to Margate, made also by the "Thames," (originally named the "Glasgow.") In the Philosophical Magazine of this year it is observed, in reference to steam boats then plying between Glasgow and Greenock, that they "take advantage of the tide, as far as circumstances permit; but, starting at different times, they are sometimes obliged to go part, or nearly the whole of their voyage, against the tide." "That at first, owing to the apparent danger of the conveyance, the number of passengers was so small, that the only steam boat then on the river, could hardly clear her expenses." Even at this period, a sea-going steamer would have been ridiculed as the offspring of a deranged imagination.

1816. The first voyage to a foreign port by a steamer: from Brighton to Dieppe. In the account of the expedition fitted out this year, to explore Africa, it is stated that "the steam engine which had been fitted on board the 'Congo,' had been removed, together with the whole of its vast machinery, as its use was found impracticable."

1817. The first Committee of the House of Commons to report on steam boats, and the first Act of Parliament for their regulation. With much simplicity they inform the Commons, "that steam engines of some construction may be applied with perfect security, *even* to passage boats." At this time seventeen large steam boats were in constant employment on the rivers in America.

1818. The "Rob Roy," of 90 tons and 30-horse power, the first vessel that proved the practicability of Steam *Sea* Navigation, by plying *regularly* between Greenock and Belfast. Mr. David Napier, of Glasgow, is entitled to the honour of having established sea-going steamers. In this year also, the "Cobourg," of 75 tons and 24-horse power, made the first voyage from Southampton to Cowes.

1819. The "Savannah," built at New York, the first steamer that crossed the Atlantic. She made the voyage from Savannah to Liverpool in 26 days. The "Talbot," of 150 tons and 60-horse power, built by Mr. David Napier, the first steamer that plied daily between Holyhead and Dublin, and between London and Calais. The first Act of Parliament to estimate the tonnage of steam boats, 59 Geo. III., c. 5. It recites, "Whereas ships or vessels have been built and constructed to be propelled by steam."

1820. Steam vessels first employed in this kingdom, for the conveyance of merchandise: coasting trade to Scotland.

1821. The "Royal Sovereign George the Fourth," of 205 tons and 80-horse power; and the "Meteor," of 190 tons and 60-horse power, the two first Government steam packets: employed between Holyhead and Howth. The first steamer that plied between Dover and Calais, the "Rob Roy," removed from the Greenock station.

1822. The "Robert Fulton" made many trips between New Orleans and Havannah.

1824. Steam vessels first employed between Jersey and the Channel Islands.

1825. The first voyage to India by a steam ship, "The Enterprise."

1827. The writer of an article on Steam Navigation, in the "Encyclopædia Edinensis," not later than twelve years back, tells us, with much earnestness, that "other accidents have happened, *and clearly prove* that steam boats ought *not* to ply in dark and stormy weather."

1829. Among many glowing discourses in praise of Fulton, in all of which he is unfairly called or spoken of as "the illustrious inventor of the steam boat," the most interesting is one delivered this year, by Judge Story, at the Mechanics' Institution, Boston, in which is an account of Fulton's first voyage, as related to him by Fulton himself. We find, that though it was nine years since public attention in America had been directed to Steam Navigation, the ridicule and incredulity with which it was first received, had lost none of their power nor influence. No sooner was it again introduced, than the same discouraging propensities burst forth with renewed violence, and, but for Fulton's efforts, might have extinguished, for many years, a power which has done more for that nation than any other invention, except Whitney's Cotton Gin. We see by the following extract, the light in which the first successful steam boat in America was considered. The description of the trial transports us to the Hudson. We are in the earliest steam boat that moved upon those waters, and share the doubts, and fears, and excitement of all on board, just at the moment when the order was given for this terrible agent to display, for the first time, its untried power against the elements. We can imagine the sanguine hopes of the projector, and enter into his

feelings of delight as the boat began to move, and rewarded his labours and discouragements in the realization of his expectations. "When," said Fulton, "I was building my first steam boat at New York, the project was viewed by the public, either with indifference or with contempt, as a visionary scheme. The language was uniformly that of scorn, or sneer, or ridicule. The loud laugh often rose at my expense, the dry jest, the wise calculation of losses and expenditures, the dull, but endless repetition of the Fulton Folly. Never did a single encouraging remark, a bright hope, or a warm wish, cross my path. At length the day arrived when the experiment was to be put into operation. To me it was a most trying and interesting occasion. The machinery was new and ill-made; many parts of it were constructed by mechanics unaccustomed to such work; and unexpected difficulties might reasonably be presumed to present themselves from other causes. The moment arrived in which the word was to be given for the vessel to move. My friends were in groups on the deck. There was anxiety mixed with fear among them. They were silent, sad, and weary. I read in their looks nothing but disaster, and almost repented of my efforts. The signal was given, and the boat moved on a short distance, and then stopped, and became immoveable. To the silence of the preceding moment, now succeeded murmurs of discontent, and agitation, and whispers, and shrugs. I could hear distinctly repeated, 'I told you it would be so; it is a foolish scheme. I wish we were well out of it.' I elevated myself upon a platform, and addressed the assembly. I stated that I knew not what was the matter; but if they would be quiet, and indulge me for half an hour, I would either go on, or abandon the voyage for that time. I went below, ex-

amined the machinery, and discovered that the cause was a slight mal-adjustment of some of the work. The boat was again put in motion. She continued to move on. All were still incredulous. None seemed willing to trust the evidence of their own senses. We left the fair city of New York; we passed through the romantic and ever varying scenery of the highlands; we descried the clustering houses of Albany; we reached its shores; and then, even then, when all seemed achieved, I was the victim of disappointment. *Imagination superseded the influence of fact. It was then doubted if it could be done again;* or if done, it was doubted if it could be made of any great value." It has been already shown, that the practicability of Steam Navigation had been established in Scotland by Symington, six years prior to this period. There is undoubted evidence that in July, 1801, Fulton had been himself carried several miles, during one of the trips performed by the "Charlotte Dundas," and had availed himself of the opportunity, and a generous permission to take notes of every particular sufficient for a similar purpose. He *knew* he should succeed, for success was no longer doubtful. He was philosopher enough to feel a confident conviction that the same causes, similarly applied, could not fail to produce the same effect in America, as he had witnessed a few years before in Scotland. His plans were formed upon the sure basis of their practical application by another; and the Americans, astonished at the verification of a prediction founded on his own prior experience, paid him all the honours of a first and successful inventor. He possessed not the magnanimity of a noble mind, ever to refer to the talented engineer who, in obscurity in the old country, had been the source whence he derived the valuable knowledge which he

turned to so good account in the new. Studiously concealing his previous experience of its success, the honour of the invention was a bait too tempting to be refused: he eagerly grasped at it, and showed his gratitude for Symington's liberality, by depriving him of the merit of the discovery. We cannot then acknowledge, upon such evidence, Fulton's claim to the title given him by Judge Story, and by every class in America—"illustrious inventor of the steam boat." Whilst public feeling and gratitude towards Fulton have been so warmly displayed in America, I have found no notice of Symington's exertions and claims, but of the slightest and coldest description. It does not seem consistent with the genius and feelings of the English, to pronounce public panegyrics in memory of the great men who have deserved well of their country. The exceptions are rare. The absence of all sentiment of this nature may be considered characteristic of the nation, since we trace this interesting and solemn custom in the history of almost every country, from the eloquent funeral orations of the Greeks and Romans, to the fervent recapitulation by the wild Indian, of the good qualities of his chief, departed to the hunting-grounds of the Great Spirit.

1831. The following extract from an anonymous pamphlet published this year, called "An Account of the Origin of Steam Boats,"* &c., will show the great progression of Steam Navigation within the last eight years, and the erroneous impression of its capabilities, even so recently as 1831. "Experience has shown, that the space required for an engine and machinery, occupy too much of a vessel to leave enough for the profitable con-

* The only work I have seen on the subject, but too imperfect for authority, and at variance with this pamphlet.

veyance of cargo, either as to tonnage or distance, to admit of a general adoption of steam for voyages to distant ports." The first Act of Parliament for the Incorporation of a Steam Shipping Company—The General Steam Navigation Company, by the 1st and 2nd William IV., c. 53; which recites, "Whereas navigation, by the aid of steam and other engines, is attended with great convenience and advantage to the public, and is a national benefit."

1832. The "Alburkah," of 60 tons and 15-horse power, built by Messrs. Laird, for river navigation, for the African expedition, the first *iron* steamer that went to sea. The "Garryowen," of 100-horse power, built at the suggestion of Mr. C. W. Williams, for the City of Dublin Steam Navigation Company, the first regular sea-going iron steamer. This substitution of material seems destined to form an era in steam navigation.

1838. The "Sirius" commenced the first steam voyage from the Old to the New World, on the 28th of March. The "Great Western" started on her first voyage to New York, on the 8th of April, and made the passage in fifteen days four hours.

1839. The "British Queen" left on her first voyage to New York, on the 10th of July.

We see at a glance, by the above, the slow growth of Steam Navigation, and how it has gradually crept on to maturity, overcoming all difficulties and discouragements. We examine with eager interest the earliest struggles of a mighty power in its infancy. We trace it when, as a mere matter of speculative science, it first attracted the slight and careless notice of the Society of the Royal Institution in the old country, and the still more contemptuous investigation and unfavourable report of the Philosophical Society in the new. We witness now, with surprise, its long and unaccount-

able neglect; the confident incredulity expressed respecting its generally useful and profitable employment, even when its practicability had been established. Steadily progressing with irresistible strength, we find it at last become the object of careful and repeated legislative enactment; and we go back again a few years to compare, somewhat incredulous at the contrast, the first feeble efforts of a power to move four tons, with its present employment to drive across the ocean, in opposition to the storms that sweep over the Atlantic, a vessel exceeding in size the largest man of war in the British Navy, compelling the very waters which she rules so triumphantly, to yield the means by which she holds them in subjection. By this example of the extreme ridicule with which a singularly useful and successful discovery was received in its progress, we are taught the folly of despising what is new. Scotland took the lead from Symington, and taught Fulton, who carried it to America. From America it naturally spread, by contiguity, to the adjoining British Plantations; and thence returned to Scotland, to complete what she had begun. Obtaining, at length, an uncertain footing in England, in 1813, it was still eight years before she roused herself from her singular apathy; when, taking it in hand in earnest, with that steady perseverance which has ever distinguished the individual efforts of her people, and the united energies of the country, in peace or war, she speedily equalled all competitors. She now rivals any State in numbers, and surpasses all nations in the grandeur and power of her steamers. The British, in Quebec, displayed considerable enterprise by their example to the mother country, in building, so early as 1814, a steamer of the size of 387 tons. But the chief merit is due to Scotland. She may indeed rest content for the next hundred years, with her contribution of talent to the great authors and great men, who will for ever render memorable the end of the last century. There is no parallel in history, but that

period when Rome held within her city, at the same time, the great cotemporaries, Cæsar, Pompey, Cato, Brutus, Livy, Horace, Virgil, and many stars of lesser magnitude. Since that brilliant constellation, no country can boast of having given to the world, within the same space of time, a Hume, a Robertson, a Scott, a Watt, and a Symington: the two first historians surpassed, in modern times, only by Gibbon; the third, the great magician, evoking and commanding like another Prospero, and the "dainty Ariel," the passions and feelings of all times, unequalled even by Shakspeare, in the universality of the enjoyment he creates; and the two last, giving not the mere, though mighty, impulse to matter in manufactures and civilization, but acting upon mind, by rousing mechanical ingenuity, and the peaceful arts, from the doze of centuries; and by the stimulus, thus thrown out, exciting the power of intellect to keep up the momentum, and increase its progression. Thus has that little speck in the waters, sent forth the master spirits to move nations, whose works influence the present, and shall be felt by generations yet unborn. In Steam Navigation, however, as in most other important inventions in this country, all is the result of individual enterprise. Government neither did anything to encourage and protect the infant power, nor has rewarded the individual who first showed the country its use and advantages. Looking at the table with our present knowledge, we feel surprised, not so much that the application of steam to navigation should have remained so long undiscovered, but, that once proved practicable, its progress should have been so slow. It is no less remarkable, that it was not investigated by some of the great men of that period, whose names are more familiar to science. But, like many other discoveries, it was received but coldly, and none anticipated, from its dawn, the surprising results that have rendered it second in importance only to the mariner's compass. That

it was not of easy achievement, may be best estimated by the length of time, and the many miscarriages that attended its accomplishment. The difficulties of all great undertakings may be so ascertained. The part Symington took in its origin only requires to be known, to associate his name with the illustrious men with which the latter end of the last century abounded.

The advocates of Fulton and Bell's pretensions to the original invention of steam navigation—for as to Taylor, he is a mere "nominis umbra"—may think this pamphlet wanting, for not dwelling at greater length on their respective merits, and showing more fully the share, I have already shown, they had in its introduction. I have only not done so, because my chief object was to find and fix permanently the real inventor; to trace a complicated river to its much disputed head, careless, to a great degree, of those little branches which only distract attention, and, if followed far, divert from the true course, leaving but little time and energy to seek its origin with the confident assurance of accuracy. However large those branches may become, and however fertilizing in their results, they are but offsets, deriving their own existence from a higher source, which if it had not been, themselves would probably never have attracted attention. I have shown that the true spring was not in America, but, taking its rise from Symington, in the old country, it flowed, through Fulton, to the new. From what has been stated in these pages, the question may be thus shortly summed up:—Hulls first suggested Steam Navigation in 1736, at a time when it was impossible, with the then state of the engine, to make it generally useful. Symington, with equal originality, not only suggested it in 1788, but, having invented a new construction of the steam engine, adequate to produce the intended effect, constructed it, applied it, and proved the practicability of his invention in that year, and in 1789. (See Fig. 2.) Mr. Miller

allowed it to be abandoned. Again, Symington proved it in 1801, 2, and 3, (see Fig, 3,) but still he was not encouraged. His own resources exhausted, poverty, not his will, compelled him to relinquish his scheme, just when success was about to reward his ingenuity and perseverance. His steam boat, however, was not destroyed. Laid by on the Forth and Clyde Canal, it naturally became, at that period, the great show and attraction to every inquiring mind, as a wonderful power that might one day master the winds and tides. It was his misfortune, not his want of success, that he could find no further means of continuing an invention which has since been attended with important consequences to the whole human race, and from which a golden harvest has been reaped. Others were more successful, though at a later period. Numbers flocked to see the boat, and drawings afforded a ready facility of transmitting to America, and elsewhere, the details, immediately money supplied the means of carrying them into execution. It has been shown how Fulton availed himself of Symington's liberality. It was, then, but a poor return, the attempt of Fulton to deprive him of the honour of the invention. The Americans, who seem born in a hurry, and whose existence is passed too continuously in "going a-head," not to be sensible of all that steam navigation has done for their country, have so perseveringly claimed the discovery for their countryman, that it is necessary to clip the wing of this Phœnix, who, with no claim to be considered as "the benefactor of the human race," and having no other sufficient fame to soar upon, would substitute the ashes of worthier men, from which to rise. Engines made by Boulton and Watt, for a steam boat built from drawings taken from the one proved practicable by Symington, in Fulton's presence, and for his satisfaction, form but a perishable foundation against "Time, the Avenger," to claim the invention of Steam Navigation. That much merit is due to Fulton and Bell, for their perseverance in overcoming the

fears and prejudices of the public—the one in America, the other in England—it were idle to deny. That they possessed considerable talent, is conceded as their indisputable right; but that either deserves to go down to posterity, entitled to the honour of the invention, is contrary to fact. We should have heard more of Symington, and less of Fulton, had the former met in England the same encouragement the latter found in America. That Fulton himself did not think very highly of the invention, will appear by the following extract from his letter to Joel Barlow, dated the 2nd of August, 1807. Speaking of the success of the "North River" Steamer, he writes, "However, I will not admit that it is half so important as the torpedo system of attack and defence." It is rather singular that our old friend, Mr. Cadwallader Colden, in his Life of Fulton, says not a word of Fulton's witnessing Symington's steam boat at work, though he gives an account of his visit to England. Symington's experiments are not even referred to. Seeking to justify his friend of the "enlarged and philanthropic views and reflections," for changing sides, and offering his services to England, when France would have nothing more to do with his torpedoes, Mr. Cadwallader Colden says, "Without feeling a partiality or enmity to either of the belligerents, he (Mr. Fulton) was desirous of engaging one of the nations at war, to give him the opportunity of trying the efficacy of his inventions." Very humane, certainly. Such "philanthropic views" would be more honoured in the breach than the observance. "If they were proved to answer his expectations," (blowing ships' companies into the air, and 'not leaving a man to relate the dreadful catastrophe,') "he was indifferent as to the temporary advantage it might give one over the other. He believed that the result would be the *permanent* happiness of *all.*" Here is a new method of making people happy, and Fulton is, at least, entitled to this invention, which no one will

seek to deprive him of. It is seldom, indeed, that a book containing so much grave humour, so admirably disguised, has come before me. Three hundred and seventy-one octavo pages are devoted to the praises of Mr. Fulton and his various inventions, one of which is thus spoken of: "In a few years, *perhaps*, all Europe will be surprised to see a flotilla of diving boats, which, on a given signal, shall, to avoid the pursuit of an enemy, plunge under water," (like ducks before a terrier,) "and rise again several leagues from the place where they descended." All Fulton did, to clear the seas with his infernal torpedoes, was to blow up a few unoffending old hulks, which, poor things, being chained fast for the purpose, and having none to protect them, could not get out of the way, and thus became the easy victims of his "prepared carcasses." "He offered," says Mr. Cadwallader Colden, "his personal services, with his torpedoes, to *compel the British vessels to be obedient*(!) to the will of the Government; but happily they were not so obstinate as to afford an opportunity of trying this terrible mode of compulsion." I dwell very unwillingly, at this time, so long upon Mr. Fulton, but there seems to be a misapprehension of the extent of his talents and claims, though both are considerable. The following sublime panegyric, by Gouverneur Morris, is another instance of the praises lavished upon Fulton as the *inventor* of Steam Navigation. Rhodomontade can no further go. "A bird hatched on the Hudson" (from an egg stolen by Fulton from Symington) "will soon people the floods of the Wolga, and cygnets descended from an American swan, glide along the surface of the Caspian Sea. Then the hoary genius of Asia, high-throned on the peak of Caucasus, *his moist eye* glistening while it glares over the ruins of Babylon, Persepolis, Jerusalem, and Palmyra, shall bow with grateful reverence to the *inventive* spirit of this western world." Now, as moist eyes are somewhat short-sighted, the "hoary genius of Asia," afore-

said, had better wipe his "moist eye," and clear up, and look a little further through the fog, if he wants to see the birth-place of the true inventor. As to the Marquess of Jouffroy's boat on the Soane, it was as unsuccessful as the experiments in America before Fulton's "North River." On this account it deserves no further mention here, though the Marquess does calculate surfaces of pistons by "round inches," an invention of equal originality and merit with his boat.

TABLE, No. 2.

AN ACCOUNT OF THE NUMBER AND TONNAGE OF STEAM VESSELS REGISTERED IN THE BRITISH EMPIRE IN 1838, SPECIFYING THE PARTICULAR PLACES TO WHICH THEY BELONG.

	Vessels.	Tonnage.
England	484	43,877
Scotland	105	13,113
Ireland	84	17,694
Total in United Kingdom	673	74,684
Guernsey, Jersey, and Man	5	709
British Plantations	44	7,323
Total registered in the British Empire	722	82,716

For the whole number of Steam Vessels, registered and not registered, *belonging* to the British Empire, in 1838, see Table, No. 3, page 143, and the Explanation of the Tables, page 145.

TABLE, No. 3.

OF THE NUMBER, TONNAGE, AND POWER OF STEAM VESSELS IN THE BRITISH EMPIRE,

Ending Christmas, 1838.

	No.	Below or between certain Tonnage.	Registered Tonnage.	Estimated Tonnage of Engine room not registered at Custom House.	Total Tonnage.	Computed Horse Power.	Computed Horse power each Vessel.	Computed Tonnage each Vessel.
	256	Below 50 tons	6,106	10,816	16,922	6,400	25	66
	145	50 to 100 „	10,267	7,458	17,725	6,866	47	122
	84	100 to 150 „	10,034	7,761	17,795	7,483	90	211
	63	150 to 200 „	10,982	7,147	18,129	7,560	120	287
	76	200 to 300 „	16,654	10,839	27,493	11,188	147	361
	41	300 to 400 „	14,247	7,580	21,827	10,914	266	532
	10	400 to 600 „	4,488	3,506	7,994	3,000	300	769
	1	679 „	679	661	1,340	450	450	1,340
	1	1053 „	1,053	963	2,016	500	500	2,016
No. of vessels registered in 1838	677	——	74,510	56,731	131,341	54,361	——	——
Not registered	83	——	4,154	5,484	9,638	2,129	50	116
Total No. in Great Britain and Ireland in 1838 .	760	——	78,664	62,215	140,879	56,490	——	——
Isles of Guernsey, Jersey, and Man, 1837 . .	6	——	832	618	1,450	600	100	241
British Plantations, 1837	44	——	8,411	7,253	15,664	6,160	140	356
Grand total belonging to the British Empire in 1838	810	——	87,907	70,086	157,993	63,250	——	——

at the Customs, for his polite and kind assistance. Accuracy and research are the chief requisites of a writer, in times when originality is hopeless. I have endeavoured, therefore, to state the Tables correctly. No. 3 is taken from the Report of 1839. The difference is trifling, but I have no means of ascertaining which is correct. Both Tables will be found in the forthcoming valuable returns of Mr. Porter, for 1838. A slight difference will also be found between Table, No. 3, and that in the "Report." It is in the tonnage of the last single steamer, meant for the "British Queen." It should have been, as here stated, 2016 tons, instead of 1855, in the "Report."

Many more private steamers have been built since these returns; but, adding only the "President" of 2336 tons, and 600 horses, to the above, the total Steam Marine of Great Britain and her dependencies, on the 1st of January, 1839, may be calculated at 160,329 tons, of the united power of 63,850 horses. Estimating each horse power at £35,* and each ton at £15, the capital invested in steam vessels cannot be less than £4,639,685, the whole belonging *to private* individuals, for the returns are exclusive of Government and Post Office steamers.

No sailing vessels are better adapted or supplied "with all the appliances and means to boot," to make quick passages, than the beautiful American liners. Built expressly for the purpose, they have made some surprising voyages to and from New York. The average passage of 24 liners in 2 years, ending in January, 1840, from New York to Liverpool, was 22 days; and from Liverpool to New York, 33 days. Four voyages from New York to Liverpool have been made in 16 days; the shortest out in 19 by the "Roscius," in December 1839. The Great Western has made 11 voyages down to January, 1840. Her average passage out is 16 days,

* The engines of the "British Queen" cost £25,000, being at the rate of £50 per horse power.

2 hours—home, 13 days 18 hours. She has occasionally gone out in 13 days and a few hours, and returned in 12 days and a half. It is no uncommon occurrence to be detained in one of the liners 30 or 40 days. When the Great Western and a liner have started at the same time, the former has generally arrived at her destination a fortnight or more before her rival. The elements have no chance against steam. Truly "knowledge *is* power."

STEAM MARINE OF THE UNITED STATES.

In no country is Steam Navigation so indispensable as in America, where lakes and rivers are scattered with singular profusion, and displayed upon a scale of surpassing grandeur.* Nature, indeed, seems to have distinguished the new world by unusual magnificence, and to have exerted there, the efforts of a first creation. The scene of her mightiest operations, she has stretched forth her hand over the country, to stamp her image in the grandest proportions. Sublime in her mountains, upon their unknown summits rest eternal snows, uninfluenced by a tropical sun, giving birth to, and nourishing, a chain of lakes of sea-like dimensions. On their heights, also, spring the fountains of many rivers, which, in a long descent, gather a large accumulation of tributary streams, and, uniting in channels of surprising size, fertilize in their course many thousand miles of plain and forest, as they roll towards the ocean a body of water, vast and inexhaustible. Nowhere are the advantages and proud bearing

* Lake Superior is 400 miles long, and, at parts, 100 broad; and over 1200 miles in circumference. The Missouri River, in connexion with the Mississippi, into which it flows, is 4,424 miles long, and navigable for 4,396 miles.

of steam boats seen upon so grand a scale, as stemming these noble rivers, which, flowing ever in one direction, with the impetuosity of a mountain torrent, sweep down, in a few days, rafts loaded with the produce of inland countries; but, owing to the violence of the current, rendered necessary for their return a tedious voyage of months. By that resistless power, the almost useless torrents are turned into great navigable rivers, startling the silence of the Far West, by the unwonted noise of the paddle, lopping off centuries of barbarism, and carrying, with unexampled rapidity, civilization and the peaceful arts into remote regions, that before resounded but to the whoop of the savage, or to the axe of the scarcely less savage and solitary backwoodsman. The average passage from New York to Albany, a distance of 150 miles, is, by its means, made against the powerful stream in about seventeen hours; and 2000 miles against the furious Mississipi are now traversed in twenty days. If it be reasonable to estimate the duration of human existence chiefly by the amount of time serviceable for the various objects of profitable life, how greatly has steam navigation added, for all useful purposes, to the lives of those whose occupation is wholly passed upon the waters, in bringing down the Hudson and Mississippi, the produce of the interior to the markets of New York and New Orleans!

DIMENSIONS OF TEN OF THE LARGEST STEAM SHIPS IN THE UNITED STATES.

Names.	Tonnage.	Horse-power.	Where employed.
Natchez	860	300	New York and Mississippi
Illinois	755	—	Lake Erie
Madison	700	—	Ditto
Massachusetts . . .	626	—	Long Island Sound
Buffalo	613	—	Lake Erie
St. Louis	550	—	Mississippi
Mediterranean . . .	490	—	Below Louisville
Uncle Sam	447	—	Louisville
North America . . .	445	—	Ohio
Mogul	414	—	Louisville

By two explosions alone, 230 persons were blown up; 130 by the "Oronoka" in 1838, and 100 by the "Moselle." The greatest number in England at one time, from the same cause, was 24, by the "Union," in 1837. It is computed that 2000 lives have been lost in America, by disasters of various kinds, since the introduction of steam boats into that country, from 1807 to 1838. In the United Kingdom, the total number ascertained down to 1838, is 634, exclusive of lives lost in boats on the Thames.

It is computed, in the Report to Congress on Steam Vessels, dated 12th December, 1838, that, at that time, 1300 steamers had been built. Of these, 260 had been lost, and 240 worn out; and as many as 800 were then employed. The total tonnage was 160,000 and the horse power 57,019. The amount of capital invested in the States in steam boats, estimating the ton at £15, and the horse power at £35, may be considered to amount to £4,395,665. In the British Empire, it amounts to £4,639,685.

The total steam power in all employments, at that period, did not exceed 100,318 horse-power—equal to the labour of about 601,808 able-bodied workmen. Of this, 6,980 horse-power was used on railroads; 36,319 for other purposes,* leaving 57,019 horse-power for steam boats. Locomotives in America were not employed until 1831. In 1839, 57 railways were in full operation, whose combined length exceeds 1600 miles; 33 others are in progress, of the aggregate amount of 2800 miles, besides 150 Railway Companies.

* In Manchester alone, nearly one fourth of this power was employed in 1838, amounting to 7,926½ horse-power. In the whole of Ireland, down to 1837, only 3,111 horse-power was in operation.

TABLE, No. 4.—Comparative Statement of the Number, Tonnage, and Power of Steam Vessels, in 1836, in all Parts of the Globe where British Consuls, Ministers, or Agents, are accredited.

PLACES.	No. of Vessels.	Tonnage.	Horse-power.	No. of Engines built in England and Scotland.	No. of Sea-going Steamers included in the preceding.	POWER OF SEA-GOING STEAMERS. From 100 to 150 horse-power.	From 150 to 200 horse-power.	From 200 to 300 horse-power.	From 300 to 400 horse-power.	From 400 to 500 horse-power.
France	67	6,621	2,991	46	13	4	—	—		
Holland	30	5,497	2,614	4	6	3	2	—		
Russia	23	unknown	2,075	unknown	8	5	1	1		
Barbary States	10	„	1,550	2	10	2	8	—		
Sweden	27	1,200	1,244	1	5	—	—	—		
Sicily	8	2,061	805	8	8	2	2	—		
Turkey	2	1,088	520	2	2	1	—	—	1	
Austria	6	665	442	5	5	2	—	—		
Portugal	4	790	380	unknown	3	1	1	—		
Tuscany	3	869	335	3	3	2	—	—		
Sardinia	5	979	315	5	5	1	—	—		
Denmark	5	625	311	4	5	—	—	—		
Belgium	3	unknown	224	3	1	—	—	1		
Prussia	3	502	200	2	3	—	—	—		
Hamburgh	3	273	192	3	2	—	—	—		
Spain	4	626	150	4	2	—	—	—		
Mexico	2	285	100	—	—	—	—	—		
Hanse Towns	2	49	68	2	2	—	—	—		
Brazil	3	270	48	3	1	—	—	—		
Mecklenburg	1	82	40	1	—	—	—	—		
Total in 1836	211	22,482	14,604	98	84	23	14	2	1	—
United States in 1838	800	160,000	57,019	—	14	5	2	—	—	—
Total combined Steam Marine of the Globe, exclusive of the British Empire	1,011	182,482	71,623	98	98	28	16	2	1	—
British Empire in 1838	811*	160,329	63,850	811	282	109	26	43	6	5
Grand Total of the Steam Marine of all Nations	1,822	342,811	135,473	909	380	137	42	45	7	5

* This includes the President.—See p. 146.

TABLE, No. 5.

RISE AND PROGRESS OF STEAM VESSELS IN THE BRITISH NAVY, 1828 to 1840.

	Number.	Horse power.
In the year 1828	4	400
„ „ 1829	7	692
„ „ 1830	8	792
„ „ 1831	11	1,212
„ „ 1832	14	1,652
„ „ 1833	19	2,552
„ „ 1834	20	2,792
„ „ 1835	21	2,928
„ „ 1836	23	3,168
„ „ 1837	24	3,308
„ „ 1838	55	6,622
„ „ 1839	61	7,691
„ „ 1840	76	10,661

The total tonnage of the 76 steam vessels, forming part of the Navy, amounts to 35,000 tons, and 10,661 horse-power.* This branch of the Navy dates its existence from no earlier period than 1828. Many of these are employed in the Post Office.

TABLE, No. 6.

STRENGTH OF THE COMBINED POWERS IN SEA-GOING STEAM-SHIPS ONLY, COMPARED WITH THE BRITISH EMPIRE.

	Below 100 h. p.	From 100 to 150 h. p.	From 150 to 200 h. p.	From 200 to 300 h. p.	From 300 to 400 h. p.	From 400 to 500 h. p.	Total.
Mercantile Steam-Marine of the British Empire, exclusive of Government Steamers .	93	109	26	43	6	5	282
The combined Steam-Marine of all Nations, including Government Steamers, ten of 200 h.p. each, being added for France—a liberal allowance	51	28	16	12	1	—	108
Superiority of Mercantile Steam-Marine alone, in favour of the British Empire	42	81	10	31	5	5	174
Add Government Frigates .	—	54	10	12	—	—	76
Total superiority of the British Empire in Sea-going Steam ships	42	135	20	43	5	5	250

* The actual horse-power of each Government Steam Frigate is not given.

Table, No. 4, is compiled from papers presented on the motion of Sir R. H. Inglis, to the House of Commons, in the Session of 1837. The returns of foreign powers are not continued beyond 1836; whereas, those for the British Empire, and the United States, are brought down to 1838. To approximate them would only lead to inaccuracy. Excepting France, where the information was refused, the Government steamers of the several powers are included in their returns. France has several fine war steam ships, but they would be unable to cope, one day, with the superior steam Navy of England. It is gratifying to find, by so many of the engines used in other countries being of British manufacture, that we still maintain our mechanical superiority. Table, No. 5, is not included in any of the previous Tables. To provide against omissions in the returns of other nations, it has been kept distinct; and it must be admitted, that such a force forms a very pretty *corps de réserve* to pick up the stragglers. For this Table, I am indebted to the third number of the Colonial Magazine, a periodical greatly wanted, devoted to circulate correct information relative to the colonies; and which has room to become one of the most useful and important works of its class. This Table has, probably, been procured from sources to which the public have not access, since I had in vain sought for it elsewhere. For all other data, I have resorted to the original documents themselves. Finding I had arrived at results different to similar Tables lately published, I went over the originals again; but I have left these unaltered.

The returns of foreign powers are brought down, as before remarked, only to 1836; and those for the British Empire and the United States, to 1838. For the purpose, therefore, of comparing the relative strength of the several powers in sea-going steamers on the 1st of January, 1840, it would probably be found, from a similar comparison of past data, that more steamers of this description have been built in the

British Empire, in 1839, than in all the other countries, since 1836. We have no extended path of inland waters to tread, as in America, nor is our capital far removed from the sea, as in France. The ocean rolls at our feet, meeting us equally at our marts of commerce, as at our chief resorts of amusement. Thus, by far the greater proportion of our steam boats are built for sea service. The above Table may, therefore, be considered for all practical purposes, as a pretty correct approximation to the *relative* strength of all powers on the globe, down to January, 1840, in that class of steam vessels which, in the event of a war, can alone be serviceable. The contemplation of our vast superiority in this branch of naval warfare, cannot but gratify every Englishman, at a period when the maritime excellence of the British Empire is despondingly depicted on the wane. The prejudices of party must yield to accurate data, or the compiler deceives his readers whilst he debases himself. The ocean child is not yet in its dotage. Without doubt, the usual naval armament is also required to maintain a dominion which has been won so well, and so nobly used. But, if steam ships of a powerful class do not take the lead in most future naval actions, their independence of the elements, their certainty and despatch, render them too serviceable not to play a very prominent part. It has been shown, by Table, No. 6, that the collective sea-going steamers of the globe, allowing 10 for the French government steamers, do not exceed 108; of these, 51 are under 80 horse-power, but 12 amount to 200, and only 1 to 400 horse-power. All the other steamers are perfectly useless, except for river navigation, being of a light draught of water, and manned with fresh water men, who are not seamen, and cannot be reckoned upon. A long experience has taught the necessity of building steam boats expressly for the single purpose for which they are designed to be employed; and thus the difference in construction and materials, between sea-going and river steam

boats, however large the vessel, is so marked, that the latter would not merely be shook to pieces by the discharge of serviceable guns, but could not live at sea. Combining our fine war frigates, which are unrivalled as a body, Government can upon any emergency call into existence, for the service of the country, at a few days' notice, a powerful fleet of 358 steam ships manned with hardy seamen in constant work. Of these, after leaving sufficient to equal in number, though of greatly superior power, the combined forces of all the nations in the globe, there will still remain our majority of 250 disposable. The Mercantile Steam-Marine of the British Empire will thus become a powerful auxiliary to Government, the efficiency of which can scarcely be estimated too highly. However various may be the opinions of individuals, of the degree in which steam ships may be beneficially employed in future warfare, if we examine the tonnage and power of those leviathans of the deep, at page 144, and take into account the heavy ordnance they could carry, especially the British Queen and President, we cannot doubt, that a new power of this description must give some considerable superiority to the side which employs it against an adversary deficient of similar means of resistance. The two last throwing into an enemy weight of metal in proportion to their size, and able to take up and maintain, independent of the wind, those positions which are so eagerly contended for by naval commanders, and the possession of which frequently decides the victory, *cæteris paribus*, would be formidable antagonists of the largest men-of-war yet built, that could be brought against them. England may soon again hoist the pennant and whip the seas. Her steamers will also, in future, form the indestructible floating bridge, over which her troops will pour to concentrate British valour and discipline upon a given point, with unerring certainty and unexampled despatch.

This is not the place to enter fully into an inquiry, to show that, in the event of a war, England would surely maintain more, rather than less, of her usual superiority on the seas; and that, however numerous and powerful may be the ships of other powers, they are still, as they were in the last war, but built for our use. Money will enable any country to build a fleet, but geographical position, and the moral and physical peculiarities, which as surely distinguish nations in accordance with such positions, as the mountains and hills of a country determine the length of the rivers and localities of cities and towns, are indispensable to form good seamen. The spirit of adventure kept alive, and urged to action by the necessity of providing subsistence, which a dense population cannot find upon an inadequate territory, has compelled the English to seek occupation upon the waters, and led them to make homes in distant lands. Colonies have sprung up as a necessary consequence, creating a vast carrying trade, and returning to the mother country streams of wealth, whose source is inexhaustible, which enlarges the more as demands are made upon it, and which disuse alone dams up. The surprising increase in her population, during an unexampled peace, has given a momentum to these causes, never surpassed. Will they cease to produce the same effects? Is the hardy endurance of vigorous constitution possessed by her people, and necessary to ensure a continuance of the most efficient seamen, in any way diminished? To pursue the subject at any length, would but lead to an extension of these passing remarks, at variance with the design. It seems, however, written in distinct characters, in the history of nations, that those well-defined and unalterable causes, which alone, or for the most part, are calculated, in nations similarly situated as England, to produce the best seamen, still exist, and in greater force, in the British Empire; have never existed, do not exist at this time, and cannot for centuries, if ever, exist

to the same extent in France, Russia, America, or in any great and prolific Continents, to separate their population, and to render their characteristics so marked, as to enable them to contend, with fair probability of success, against British seamen. So much has been said lately of the formidable naval strength of France, that I will but add a few words by way of contrast with her indomitable conqueror. Whilst Venice, Holland, Spain, and Portugal have each, in her palmy days, furnished her contingent of good navigators and naval heroes, France has supplied few in comparison with her territorial sway and revenues. To enumerate those of England, we must take the muster-roll of her history in the navy, in commerce, and in enterprise. It is idle to expect that the first four of these powers will ever recover strength, to become formidable antagonists of Great Britain on her proper element, when the increase of her population over her deaths, exceed eight hundred a day. France has never been a Naval power. Are, then, those causes changed, or are they now changing, which hitherto have prevented her giving birth to, and continuing a numerous race of hardy seamen? Frenchmen can possess no feeling for the Navy—

> "Besides, they are all for the land service,
> Not emulating Nelson, Duncan, Howe, and Jervis."

They have no predilection, founded on those glorious associations of triumph and glory, that feed their national vanity in the army. With them there is no confidence of future victory at sea to urge them on, which past success makes so alluring; which snatches a triumph from the uncertain hand of fortune, by anticipating it; "making that true by thinking it, which had been false without." With them, as regards the Navy, it is NON *possunt quia* NON *posse videntur;* with Englishmen the reverse, *Possunt quia posse videntur.* This is everything. Confidence gives the nerve to dare, the arm to

execute. Like the sword of Brennus, it turns the scale. "To do greatly" is to "dare greatly:" daring, it is done. Encourage still this feeling, by equal ships, sufficient crew, and *honest* pay; inspire it in the nation, and the navy will continue invincible. Mortification and defeat at sea have followed the most vigorous efforts of the French, and tarnished a national glory, the stain of which no exertions can remove.

So long as the springs of action which regulate the human mind remain, so long must England and France maintain their relative strength upon the seas. We do not find that Frenchmen, as individuals, are different from the rest of mankind, and will follow an occupation where failure is the general rule, success the exception. If compelled to choose, they will naturally prefer a service where the contrary has prevailed. To become great at sea, is not in their power. It is contending against their nature. Their country refuses them the necessary physical and mental capabilities. Theirs is essentially a military nation, ours as distinct a naval nation, though we have not shown deficient capabilities as regards military glory. But the hand of Providence, for some wise purpose, has stamped, in characters too legible to be unread, directions to the several governments of the earth:—To France and all Continental States—Maintain armies to protect your territories from the aggression of your neighbours. To England and maritime States—Encourage a navy to protect your islands and colonies. We dislike what we perform not well; and, especially when experience has taught us we shall not succeed, we naturally turn our attention to something else. Though Sir Joshua Reynolds has concurred in the opinion of Dr. Johnson, who denied to original talent any particular bent of the mind, and said, that accident alone directs great powers to that path of eminence in which they are conspicuous, we are not to be blinded by the authority of great names, to believe, however much we may revere the talent,

what the experience of biography contradicts. Nature, besides, has implanted propensities in men, by which they seek, from natural, not acquired aptitude, those various occupations which have led to the division of labour and to distinct classes of society. If the military genius of France were directed to the sea, would it produce the same effects on that element as it has done on land? What did all Napoleon's gigantic efforts to form a navy effect, and what was the result?—the annihilation of half the fleet of his overgrown power, and the addition of the other half, to swell our own. We stripped France of nearly every stick upon which a sail could be hoisted, and then we stripped her of her colonies. We shall do so again. Well was that distinction drawn in the power of her Emperor.

"Then haste thee to thy sullen isle,
And gaze upon the sea;
That element may meet thy smile—
It ne'er was ruled by thee."

The French, constitutionally, hate the sea more than any other nation, without feeling the necessity that drives Islanders to follow it. Necessity in the poorer classes, pride and poverty in the higher, for the most part create seamen even in the British Empire. The same causes that compel Englishmen to follow the sea, are not in operation in America. So long as the boundless and prolific plains of that vast country remain untenanted, and individuals continue so constituted as to prefer ease and comparative plenty, to broken rest, hardships of all kinds, a life of momentary peril and bad pay, so long will America want native seamen. It is notorious, that in the late war she fought us with our own sailors. There is more to fear, perhaps, from the hardy enduring Russians, though it is idle employment to dwell upon those stirring feelings prevalent among individuals, which instruct us that a nation of serfs could never contend

successfully with the vigorous race of a free and enlightened people; more particularly of a country so composed as the British Empire. The territories of Russia, besides, are too extended and various in climate to give rise to the same causes which lead Islanders to the sea, or to afford the same facilities to form a nursery for seamen, as the United Kingdom, where the means of subsistence press so closely upon population, that out of twenty-eight millions of people, twenty millions live from hand to mouth; where the births over deaths exceed eight hundred a day, and where, in some parts of Ireland, there exist 250 mouths to the square mile.

There may be nothing new in any of these observations, it being difficult to write what is original, about anything; but I would not waste the reader's time to repeat what I had seen elsewhere: they are deduced, not from books, but from man, from experience, inquiry, comparison, and reflection. That knowledge is most valuable to the statesman, which, founded on sufficient experience, forms part of a body of facts to speculate upon important national objects, or to serve as the basis for proper legislative enactments, to ensure their continuance. We should not throw away one fact. At the risk, then, of the imputation of egotism, I shall briefly illustrate, by a few examples, taken from my own family, the correctness of the assertion, that the Navy of every State, even that of the British Empire, is the offspring chiefly of necessity and pride; and, in founding upon the greater prevalence of these qualities in this country, the conviction of the continuance of our naval superiority, if that honest remunerative encouragement be given to it, which no service of the State more requires or deserves.

Necessity and the pride of independence have driven every member of our family to the sea. But, without going to an earlier period than will enable me to speak from my own knowledge, my grandfather, father, uncle, and cousins, and all their

connexions, were sailors. The contrast between the fortunes of some of them, during the last war, may not be uninteresting to notice, if it serve but to show the inadequate remuneration in the naval service. The experience of individuals, however limited, must go for something; and, in stating the following facts, I know that I am stating the case of thousands. My grandfather went to sea in the merchant service, and became a considerable shipowner, commanding his own vessels. He met many reverses; he saw three fine ships burnt before his eyes, whilst a prisoner on board one of the French men-of-war. In a few hours, however, he witnessed a glorious revenge, in the destruction of the French fleet by Lord Howe, on the celebrated 1st of June, though it was followed by his own individual mortification, since the ship, which had captured him, and from which he saw the fight, made her escape. It would be difficult, perhaps, to find a more trying event, unrelieved by a single consolation but the satisfaction that his enemy had received a thorough thrashing from his countrymen. Notwithstanding these losses, and being twice a prisoner in France, once in Spain, shipwrecked, present at the evacuation of Boston and Philadelphia, and, after landing, as a volunteer, the troops at the battle of Bunker's Hill, when, to use his own expression, "the shots flew about him like peas over a pigeon's back," such were the profits of those stirring and eventful times, that he retired with a decent competency, and died at the age of 89, in November, 1836. My father chose the navy, but, though his career would have been eminently successful, from the possession and exercise of those qualities which command success, "making the iron hot by striking it," he saw the poverty of the service, and fortunately turned his attention to commerce, became a shipowner, and, after meeting with his share of imprisonment and hardships, though he died early, left a provision, which would be considered great or small, as there

were many or few to share it. Both disliked the sea, though not from natural antipathy; and their experience, which was considerable, rarely met with an individual who followed it from choice. The following is a painful contrast:—My uncle, unfortunately for his family, continued in the Navy, and died a post-captain, which rank takes precedence of a colonel. He gave me, on his death-bed, a few months ago, the sword he had worn in many fights, and when, in command of the "slaughter-deck" of the Neptune, that ship took the lead in the capture of the Santissima Trinidada, at Trafalgar. I have heard him all but curse his rank, and a niggardly service, which, after taking the best part of his life, and leaving him incapable of following any other occupation, generously gave him 10*s*. 6*d*. a day, to support the appearance of a gentleman, and to educate a family of six children; compelling him to be an exile from his native country, to enable him to exist. He felt the contrast. The only anxiety he expressed to the writer, when dying, was, that he had not saved enough to discharge those extra expenses which his illness had rendered unavoidable. A man more severely honourable, or determined against debt, has not existed. Yet his family were compelled, and, for the example, were allowed (I have no shame in stating the truth,) to petition the Naval Compassionate Fund to bury him. His half-pay died with him. It is needless to say, he had no cause to like the service. In the Navy all his life, he has assured me he seldom met with a sailor who became one from anything but necessity, so bad was the pay, and so severe the duties. Pride and necessity, which led the father to the sea, influenced his two sons. I may assert that they are fine specimens of British sailors, with physical capabilities to lead to a liking of it, proper men indeed, fit "to scale a fortress or—a nunnery." Yet the eldest, after being shipwrecked on New Zealand, living among the savages, and suffering much, returned four years ago, and declared he

would never follow a profession where nothing was to be got but hardships of all kinds, and no compensation, and which had already left his family so badly provided. He left England, in 1835, with £5 in his pocket, destined for America, there to seek his fortune on a less treacherous element. He is now settled in comparative independence in Détroit, married, and writes, "I am only too happy, and fear it cannot last." The other son was favoured with a midshipman's birth, in consideration of his father's services; but, with no prospect of promotion or of war, he descended from the station of a gentleman in the navy, and, greatly to his credit, shipped himself as common cabin boy in the merchant service, to work his way before the mast. He has been to sea eleven years, and, having just returned with his share of salvage, for a gallant act in rescuing a vessel off Corunna, has given up the sea, and is now about to join his brother at Détroit.

So far as they go, these are indisputable facts. I have mentioned them simply to illustrate and confirm my deductions: any other inference would be unfair. I can further support them. When I have had a spare hour, I have delighted to go to the docks and there single out some model of a craft, dwell upon her symmetry and proportions, and beautiful spars, and converse with her seamen. I never found any from choice. I offered one a situation on shore; he joyfully left the sea at once, and has never returned to it. Now, if these observations are considered with reference to those principles which govern the actions of mankind, they will go some way to prove, that, as few individuals follow the sea from liking alone, and whilst they can settle in the rich soils of the Canadas, America, or New Holland, and, in a few years, gather round them the domestic comforts of a married life, with a growing independence, the Navy requires, as it surely deserves, somewhat more encouragement than it at present receives. It is not a natural distaste to the sea that

creates the abhorrence I have so frequently noticed. It is the bad pay that causes an artificial dislike to spring up, which strengthens with every hardship and danger. Without doubt, in a maritime nation like this, there exists, and would be considerably more, enthusiasm for the Navy, which might become the most popular branch of the United Service, if maintained with the liberality and in the style in which the chief support of the existence of the British Empire, as an independent nation, ought to be preserved. Every other branch of the State should be subordinate to it, as was the case in relation to the army in France. Buonaparte, in the insolence of irresponsible tyranny, even went so far as to decree, that no female, possessing £250 a year and upwards, should marry any one but a soldier. What the army became in such hands, let the miraculous triumphs in Italy, and for fifteen years, attest. The Navy of England should, likewise, become the crowning mark of distinction—the chief, if not the only, passport to the highest rank and honour that the country can bestow. Had this object been followed out to the full extent of the principle, and the maxim of England's best policy steadily pursued, "Ships, Colonies, and Commerce," a prodigious increase of debt would have been avoided, the supply of the home trade of the colonies with the manufactures of Great Britain, compensating, in time, for continental deficiencies, even had it been possible for Buonaparte to continue the restriction. If this natural policy, the foundation-stone of Britain's supremacy, be chiefly and continuously pursued, she may defy the world in arms, and, secure in her dominion of the seas, and the millions of her subjects in the most valuable portions of her colonies, supply, independent of foreign trade, all the wants and luxuries of a great and wealthy people, and consolidate a power that shall pave the way for one universal language over the finest and greater portion of the globe.

CONCLUDING OBSERVATIONS.

"The history of Empires is the record of human misery; the history of the Sciences is that of the greatness and happiness of mankind."—*Gibbon.*

In the foregoing chapters I have traced, with no little interest, the rise and progress of Steam Navigation, an agent of mighty purposes, and, excepting the art of printing, without example in the history of man. It has sprung up in silence, scarcely noticed; and made its way without patronage, by its own inherent vigour and usefulness. A powerful spirit is amongst us, wielding the destinies of the human race, urging on with irresistible strides that cannot retrograde, the civilization of nations. In peace it cheapens the luxuries of the rich, supplies more abundantly the wants of the poorest, whilst it multiplies, without limit, our pleasures; in war it will give certainty to the operations of armies, and diminish the duration of their service. No longer dependent upon the elements, despatches or succours will be transmitted with certainty and speed; and it may be considered as the first link of those discoveries which will fight the battle of humanity. Wave after wave of emigration already rolls across the ocean, and, breaking upon the shores of the vast continent of Australia, disperses only to be succeeded by others of greater magnitude. Members of a great nation are founding seats of future empires in distant lands, carrying with them the press as the lever, steam navigation as the fulcrum. These are the weapons which shall become formidable when directed by British philanthropy, capital, and skill, and by which their future conquests shall be forced onwards. Not dreaded as conquerors, like the Spaniards, but received as friends by the value of such gifts, instead of exterminating a people to

possess their lands, and writing, as heretofore, the history of acquisitions in annals of blood, and sickening injustice that can never die, these agents of improvement will speedily break down the barriers of nature and of centuries, and, by causing a community of interests to spring up, civilize the natives, and establish more firmly the moral influence of the British name. The lust of conquest, and the perpetration of the horrible atrocities which disgrace the page of humanity to secure it, must yield before these mightier and more lasting conquerors. Long have the extensive rivers of America, and her inland seas, been alive with the animating presence of the steam boat; and when it shall have explored, to their several sources, the large channels of internal communication in India, Africa, and New Holland, it will open fields for British commerce and enterprise as unbounded as valuable. Where shall we fix the limits to their progress? When the extensive waters of the Indus, the Ganges, and the Burrampooter of India; of the Nile, the Niger, the Congo, Senegal, and Gambia in Africa; of the Murray, the Morrumbidgee, and Hastings in Australia, shall be covered with steam boats, and a new interest given to the country, and the millions of people with whom it will open a speedy and certain communication, shall be brought within the circle of civilization, the mind can scarcely grasp the effect these will produce upon the British Empire, her commerce, her revenues, and her debt. The last may then become the key-stone of the arch to consolidate the fabric, instead of being a burthen grievous to be borne.* The Christian and Philanthropist need but to become acquainted with the state of India, and glance over the myriads in that vast country, to learn the frequent recurrence of the most desolating famines. He will there gauge the depth of a poverty and wretchedness which

* See what was said of the National Debt before the war, at page 79.

no language can describe. He will see Famine, and its attendant, Disease, stalking across the length and breadth of the land, sweeping before them the helpless inhabitants, depopulating towns, and devastating territories. The dead and dying bodies of human beings will be his finger-posts, to mark the track of these terrible scourges. He will find that hundreds of thousands have died by want, in a rich country capable of feeding double the population, and governed by rulers professing the compassionate doctrines of Christianity. He will learn the extremity of that suffering, when mothers have forgot their nature in their feelings, and have drowned their little ones, not to rescue them, like the Grecian women, from the hands of a merciless enemy, but to save them from a more merciless conqueror, and themselves the prolonged agonies of their infants dying before their eyes by the slow degrees of want, unable to supply the nourishment which exhausted nature refuses. Facilities of intercourse by steam, will supply the means of relieving such distress, by opening out the unbounded and prolific soil for cultivation, and, by the employment of the inhabitants, make available this cheap conveyance for the produce. When we find that in less than fifty years colonies have sprung up in Sydney and Van Diemen's Land, whose inhabitants consume £5 per head of our manufactures, how inexhaustible the wealth that will flow into this country, if but a portion of the hundred millions of British India, who do not contribute sixpenny-worth per head, shall be fully and profitably employed, causing new wants to spring up, with the means of gratifying their demands equal to the supply! If we look to the bounties of climate and soil which nature has so prodigally bestowed upon New Holland and India, we shall find that they are fully adequate to supply the wool, cotton, silk, and tea for the consumption of the world. Already is the wool from South Australia superseding that of Germany and Spain,

when, in the year 1810, not more than 167 lbs. were exported from that colony, yet, in 1837, it amounted to 7,060,525 lbs. India, it is established beyond dispute, possesses every facility to supply Great Britain with all the cotton we now take from the liberty-preaching slave-dealers of the United States, which, in 1838, amounted to 355,709,586 lbs.* These are truly vast and almost boundless fields for commerce, and such long voyages will afford the most excellent nursery for the continuance of our maritime superiority. It does not seem destined either that China is to remain much longer shut up in her own selfish policy, depriving the myriads of her people of the advantages of civilization and mutual commerce, to gratify the caprice of a barbarous despot, who would apply to foreign nations the cold-blooded and unprincipled rule of *lex talionis*. Coming events cast their shadows before. Whilst these lines are passing from my pen, is England applying the wedge which never yet failed to penetrate to the remotest regions, when struck by the energy and perseverance of her people. The haughty Emperor of the "Celestial Empire," who now looks down with so much pity and contempt upon the "outer barbarians," may find, too late, that, if justly provoked by atrocities and indignities committed on these hitherto unresisting "barbarians," the

* It is not merely established that all the cotton consumed by Great Britain can be grown in India, but that it can be grown cheaper; and, notwithstanding the greater distance, be delivered cheaper. The growth of cotton in India is an object of the greatest national importance, particularly at this time, as a channel to absorb the great capitals which will be diverted from the pernicious opium cultivation. The minute of the Governor General, Lord Auckland, on the subject, dated the 14th of August, 1839, is full of interest. The proper refusal of the Chinese to receive any more of our poison may turn the attention of the cultivator of the poppy to this far more humane employment for his wealth, and be thus productive of the most beneficial results to the whole British Empire.

wedge can make its way even to "the central flowery land," and split it into convenient portions for a milder and more Christianized sway, when directed by the penetrating skill of "the barbarian eye." The present is one of those grand opportunities which seldom occur in the history of nations. A justifiable, yet firm policy, may, at length, pave the way for a free and familiar intercourse with the three hundred millions of her people, unshackled by the degrading fetters with which the British merchants have hitherto been loaded. The worrying and petty restrictions upon fair and open trade have been borne too long: it is time the British Lion should rouse itself from its long sleep, and shake off these dishonourable conditions, and establish, upon a firm, lasting, and equitable basis, a commercial intercourse of a community of interests. Then, intersected as this vast Empire is with some of the finest navigable rivers in the globe, England having the command of the seas on the one hand, and of India on the other, may, by means of Steam Boats, open and retain the chief trade of the swarming inhabitants of the inland countries, and find there a new world for commerce and enterprise, as rich a harvest, and more lasting, than was New Spain to the Spaniards. Few can doubt that England is yet in her infancy, that she will maintain the lead she has taken, and the Queen of the Ocean, as the centre of civilization and peace, reign Empress of the greater portion of the world. What nation is likely to deprive her of her sway? or, are swarms of savages, from the unknown interior of Africa or Australia, to sweep down, like a second deluge of barbarians, to conquer Old England, and leave her great only by her ruins? Lord Bacon has said, in his essay "Of the Vicissitude of Things," that "in the youth of a State, arms do flourish; in the middle age of a State, learning; and then both of them together for a time: in the declining age of a State, mechanical arts and merchandise." Yet secure against

revolution, by the safety-valves of her colonies, and saved from degeneracy by this nursery of a bold and vigorous race, let us hope that an Empire so free is destined to become the single exception to establish the rule—that nations, like individuals, have their rise, maturity, and decay. By the power of steam, too, those beautiful islands, distinguished as the Polynesia, which, scattered in groups, stud so thickly the Pacific—and the sun shines not upon fairer portions of the earth—shall be called from the solitude of their first creation, to form a portion of those colonies, which the richest and most skilful nation is securing, by the softening influence of the peaceful arts, and by the unwonted operation of philanthropy, enterprise, and commerce.

But do we read facts, when we turn back a few pages, and find that this great power is but of yesterday, and that those who are yet in the vigour of existence witnessed its rise? Is it barely credible, the evidence afforded by these pages, of the incredulity with which it was received, and the scorn and pity excited for "the idle and visionary projector," who struggled to the death to introduce an invention which now proudly animates ships exceeding the dimensions of the largest men-of-war in the navy; covers the seas and rivers of every civilized nation with its presence; turning the ocean into one great railroad, the highway of nations? Was it, in truth, this discovery that was branded as "an idle and whimsical project, unworthy of legislative attention," in the grave House of Assembly of that nation which, a few years before, had the noble daring to become free when it deserved freedom, and, worthy of their descent, preserved the indomitable spirit of the father land to maintain it? When we reflect upon this fact, and that the three earliest projectors, Symington, Fulton, and Bell, in relation to the magnitude of the discovery, died steeped in the bitterest poverty, we feel concern for the apparently inevitable doom which awaits the future benefactors

DESCRIPTION OF DRAWINGS
OF THE LATE WILLIAM SYMINGTON'S INVENTIONS,

FROM THE ORIGINALS IN POSSESSION OF HIS FAMILY.

FIG. I.

STEAM CARRIAGE.—1786.

A. Drum, fixed upon the hind axle.—B. Tooth and ratchet wheels.—C. Rack Rods, one on each side of the drum; the alternate action of which, upon the tooth and ratchet wheels, produce the rotatory motion.—D. Cylinder.—E. Boiler, supplied from the condenser.—FF. Direction pulleys.—G. Condenser.—H. Steam pipe.—I. Water tank.

FIG. II.

FIRST BOAT MOVED BY STEAM ON BRITISH WATERS.—TWIN-BOAT.—1788-9.

AA. Cylinders.—B. Boiler.—C. Steam pipe.—DD. Air-pump rods.—EE. Connecting chains.—FF. Direction Pulleys.—GG. Paddle wheels, situated and wrought in a trough, extending from stem to stern of the boat, and allowing free ingress and egress to the water. HH. Ratchet wheels, for communicating motion to the paddles.—II. Flotation line.

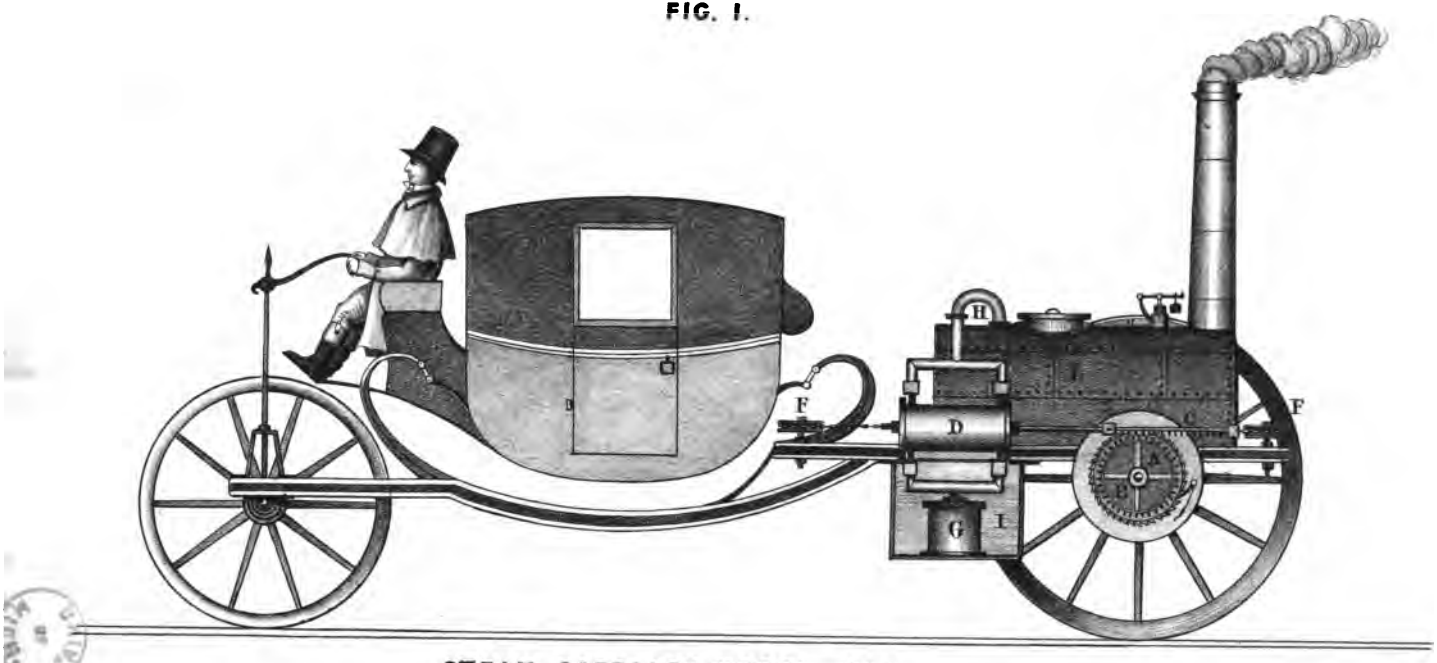
FIG. III.

THE CHARLOTTE DUNDAS, THE FIRST STEAM BOAT THAT TOOK A VESSEL IN TOW.—1801-2-3.

A. Cylinder.—B. Boiler.—C. Steam pipe.—D. Eduction pipe.—E. Condenser and air-pump.—G. Hand gear and pump rod.—H. Piston and connecting rod, supported by the friction wheels.—I. Rod, which communicates motion to the air-pump lever.—J. Crank.—K. Paddle wheel, situated in a cavity in the centre of the stern of the vessel.—LL. Paddle wheel, cavity open behind and below to the water.—M. Steer wheel.—NN. Flotation line.

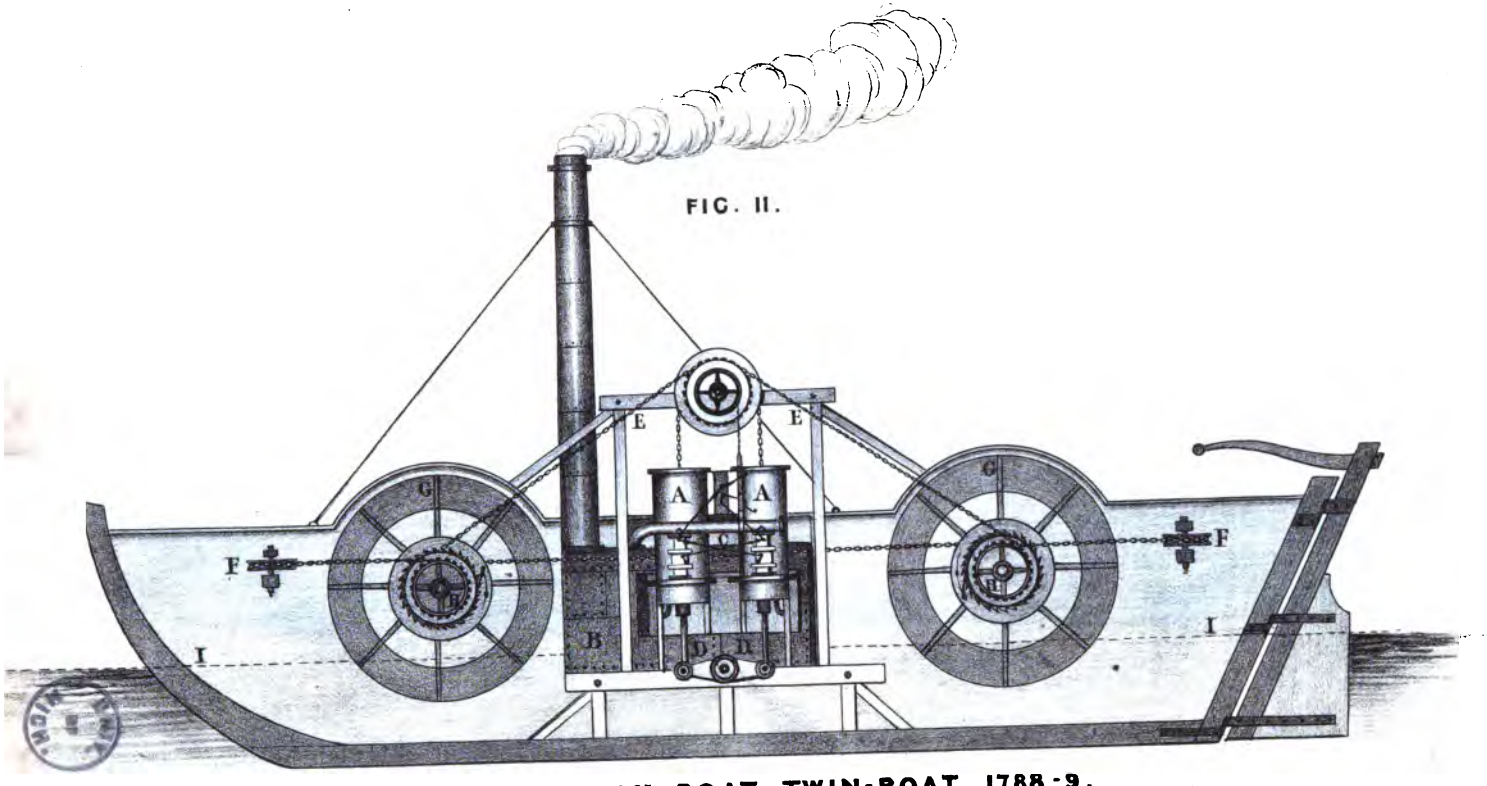
The boat was steered by two rudders, connected by iron rods, and worked in the prow, as represented.

FIG. I.



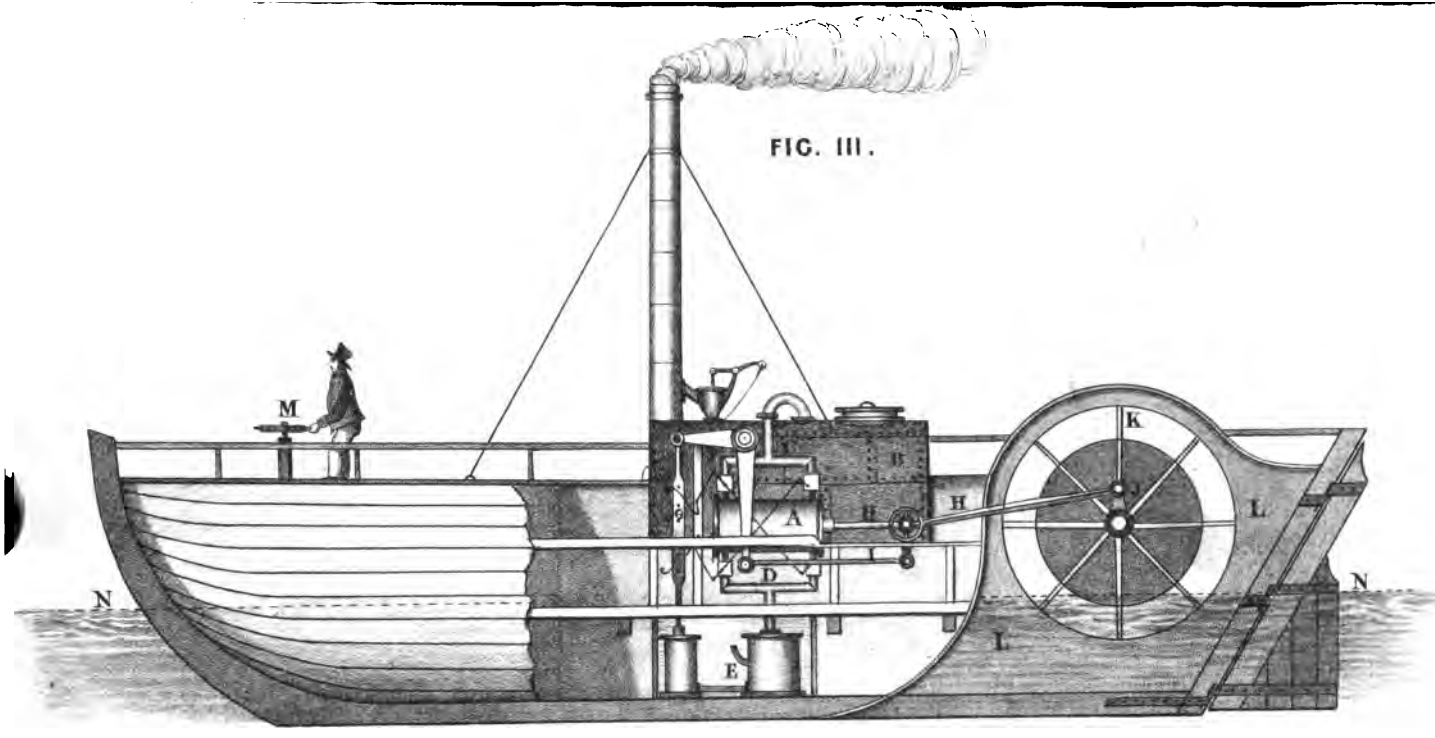
STEAM CARRIAGE MODEL - 1786.

FIG. II.



THE FIRST STEAM BOAT TWIN-BOAT. 1788-9.

FIG. III.



THE CHARLOTTE DUNDAS _ 1801-2-3.

MICH. UNIV. OF

ERRATA.

At page 70, second line from the bottom, read "1669" for "1653."

At page 90, seventh line from the top, read "truth or error," for "truth or falsehood," which will convey the only meaning the writer intended.

At pages 156 and 159, where the excess of births over deaths is spoken of, the United Kingdom is meant, not simply Great Britain.